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# NOVEMBER

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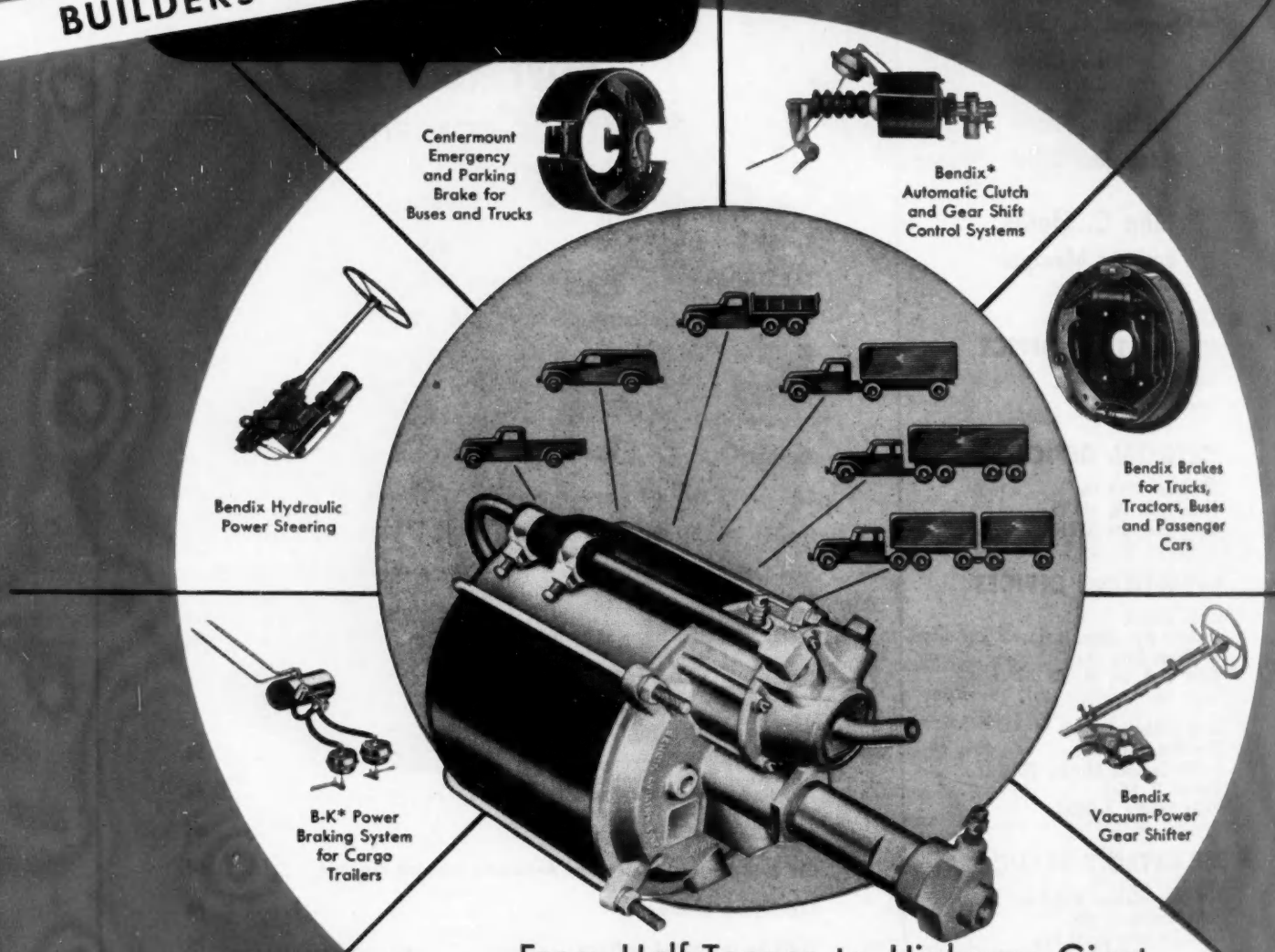
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# LEADERSHIP—

## *Industry's Crying Need*

EXCERPTS FROM PAPER BY*

**J. E. Gulick**

General Manager, Tire Division,
B. F. Goodrich Co.

LEADERSHIP is the crying need of industry. Leaders are perishable and must constantly be replaced, and with the strain of the war years, good leaders are perishing faster than they can be replaced.

Leaders will be recognized by their success in being followed—and they will be followed because they apply sound principles in their human relations. . . . Sound human relations require intelligence, tolerance, understanding, and the sincere application of the Golden Rule. That is why it is so difficult to accomplish the results that will stamp us as real leaders, because the Golden Rule seems so difficult of application.

If we aspire to lead, we must be strong and we must be courageous. We must have a keen desire to be of service.

Man's dependence on man is becoming more and more pronounced. It appears that rugged individualism has waned—or is waning—and in its place we have cooperatives, government regimentation, paternalism and other isms, much too many in number. Why? Because of a lack of intelligent, unselfish leadership!

As engineers, you SAE men are leaders—or should be. Some of you probably lead small development groups where the need for leadership is seemingly outweighed by the need for technical skill, but others are leaders of large production operations where human relations are of prime importance. . . . In neither case can you afford to neglect the primary challenge. The degree to which you are confronted with the problem depends upon your relative responsibilities in the scheme of the management of which you are a part. If you would lead, you must know human likes and dislikes; you must know human development; and you must know human standards. . . . You must always remember that God created all men in his image and that man is a living, breathing, thinking organism.

*The leader must know all about what man is.*

He can expect different results from everyone he contacts. He will expect different results depending upon his attitude toward each individual.

If he considers every human merely a handful of chemicals—a commodity which contains enough fat to make seven bars of soap, enough iron to manufacture a good size nail, sufficient sugar to fill an ordinary bowl, enough lime to paint a chicken coop, enough phosphorous to make about 200 matches, sufficient magnesium to furnish a good cathartic, enough sulfur and a few other chemicals to set off a small toy cannon—he will, each time he contacts an individual, be likely to upset the social order. He, as an engineer, knows that every point of contact is a potenial point of friction. He must re-

* Paper "The Leader and Human Relations" was presented at SAE National Production Meeting, Cleveland, Oct. 21, 1947.

member that most individuals want to help and be helped. They want to work and to play and to live and to love and to progress, to expand spiritually, mentally, and materially. They expect to suffer and to sacrifice. If he remembers these things, he will be better able to furnish the necessary lubricant that will prevent the generation of heat at these potential points of friction.

Only those who understand humans and human relations can expect to continue and progress as leaders. If the crying need of today is leadership, where shall we look? Why to those who are being of greatest service to men who have the qualities to inspire confidence, men who have the qualities to obtain harmonious action from groups of individuals, men who will be followed through thick and thin to the ultimate benefit of society because such men are leaders. They are servants—I said servants—not slaves.

Leaders such as these are developed only because they overcome obstacles which nature provides for tripping all of us.

This leader has fairness and squareness that emanates in rays to those he contacts. No dictatorial powers can be substituted to gain the loyalty and accord that can be acquired by the leader, that one who is big enough to win for himself his place in the sun.

Men who will rise to the occasion possess complete understanding of human values. They know the value of time, and they divide it in such a manner that a proper share is devoted to work, a proper share devoted to thought, an amount to fellowmen, some for self-improvement, and a part to God. The man who will rise to the occasion must recognize that time is the most precious asset in his or any man's life. He will not waste time nor cause it to be wasted by others.

*The real leader understands the success of perseverance.*

He will be confronted by rebuffs and reversals, but these will not stop him in his efforts. He realizes fully that failure is only temporary, if he keeps pushing toward his goal. He knows a team that quits is licked; therefore, he will never admit defeat. He will admit error, but in admitting error he will continually push forward to attain a definite objective.

*The real leader has a keen desire to work and finds pleasure in his work.*

He will not permit his intelligence or his desires to be dulled by idleness. There is a joy in work; there is a joy in doing something that has a definite end, whether that end be for pay or whether it be for other than pay. The good leader will radiate this joy of working to those with whom he has contact.

*The leader has the ability as an individual to merit and enjoy the confidence of other humans.*

He can improve this ability if he carries with him a dignified simplicity in his aspirations to arrive at great heights. He will not forget the simplest things that made it possible for him to attain his position or responsibility. He can take a lesson from the kings who, though destined from birth to rule, must be the very essence of simplicity and must be the personification of service.

Character is worth everything, and character will be protected by him who would gain confidence from others. Character is always with one, even when reputation has disappeared. And if one's character is well guarded, then one's reputation will reflect that character.

*Kindness is another attribute of the leader.*

It comes from an attitude which is easy to assume and which must be retained. It has the power to provide uniformity of action.

Superficial kindness is not enough. Real leaders will be kind in their thoughts and kind in their activities, and they will retain this power of kindness against all odds. They will be kind and thoughtful in all instances.

*The leader understands the influence of example.*

There is no better way to obtain concerted action than by setting an example—an example too big to be ignored. Who can say that he is not being constantly observed? Who can say that he is not being constantly imitated in the things that he does? No leader can afford to be indifferent in his actions, because if he is indifferent, he makes it easy for the man whom he is attempting to lead to become indifferent also.

*One who would seek leadership or retain leadership must have a keen understanding of the obligation of his duty.*

Any individual who would inspire cooperative effort among those with whom he has contact, will appreciate and assume the obligation of any duty that may be imposed upon him, irrespective of how simple or menial the duty may be. He will be firm to keep faith with those who have placed upon his shoulders the responsibility for carrying out a given task.

*The leader must possess the rare virtue that goes hand in hand with kindness—that is patience.*

Patience must be a part of the leader's life because impatience tears down and destroys much of the good work which has been accomplished. A leader should be dissatisfied enough so that he will constantly strive to serve better and better, but he will not be impatient enough to destroy his or others good works. He will improve his talents, he will use those gifts which were put into his being. He will use them to gain the ends which he seeks. He will develop the talents of those around him, and in so doing, he will create greater understanding on the part of everyone. He will appreciate the joy of originating. He will show appreciation for the efforts of those who are originating, no matter how small their contribution may be toward bringing about better social and economic conditions.

*The leader will encourage constant thought for*

*improved ways of doing things and for originating new things to be done.*

He will possess initiative to a degree that will be contagious so that he will be able to push foward and be able to have his group go forward with him, no matter what the undertaking may be.

Picture an individual with these qualifications, developed through his own efforts and kept properly alive. Can you picture him in any spot other than a position of service and responsibility? There is no other place, for men with these qualifications naturally gravitate to positions of service and responsibility. When a man knows, when he knows for himself, that he possesses an appreciation of these characteristics and recognizes that they are of paramount importance, he cannot help but have an understanding of all human activities. He will know that the external man he sees is not the man himself, but only the house in which the man dwells. He will know that irrespective of size, or form of body, or expression of face, the real man is invisible and he will act on this knowledge.

As leaders, all of us must recognize that to be real powers in carrying on the work of our social and economic order, we must be imbued with the realization that man is born to perform a definite role in life and that he is not just cosmic fertilizer. We must believe that man is a living, breathing, thinking organism, with a soul that originated from a Divine source. Man is not a handful of chemicals, a vile thing that came up from the mire and muck and mud of the swamps of some remote jungle.

It is every leader's responsibility to develop for himself a philosophy of life that he can impart to those around him. He must know all the aims, and must appreciate the desires, the likes and dislikes, and the peculiar imaginings which are in the other man's mind. A real leader will develop, and give to those under his leadership, a philosophy which will help him and will help them to stand up against the figurative clip on the chin which drives men back from careless ways into harmony with the laws of mankind. His philosophy will teach them to benefit from the ravages of reversals, and urge them to greater strivings and to glorious achievement. He will carry on under a philosophy that helps those around him surmount the steepness and the roughness of the way so that they may be prepared to accept those virtues which only are developed by surmounting the dark obstacles of discouragement . . . a philosophy that teaches men to appreciate the meaning of failure, something which burns out of them any thought of easy victory, and which toughens the muscles of their minds for greater battles and greater triumphs, a virtue that teaches them to benefit by mistakes that they inevitably must make.

*The leader will help others develop a strength of will and character that will enable them to withstand disillusionments and disappointments.*

Even though these disillusionments and disappointments retard for a while, they can be depended upon, if properly used, to clear the way and to add to desire. Leaders must develop strength sufficient to govern their appetites and their passions. Once having developed such strength of will, they can better enjoy the power which these very things impart when they are under control.

*The greatest attribute of a leader is the willingness to extend a helping hand to his neighbors because he recognizes their weaknesses and failures.*

He will benefit not alone by his own shortcomings, not alone by his own sorrows and loneliness. He will benefit also in helping his neighbor overcome sorrows, loneliness and shortcomings. The leader will have a deeper sympathy for others. Above all, he will be glad to be of service.

Summing up, these personal characteristics and qualifications for leadership are:

1. Self-control and self-discipline.
2. Patience and tolerance of other people.
3. Respect for truth and fact.
4. Keeping of promises and commitments.
5. Willingness to work as a part of life.
6. The ability to make the best of things and refuse to be licked.

It is of utmost importance that we have this kind of leadership if we are to carry on the social and economic order which has come to mean so much to us in America.

We cannot temporize with our lives. We must learn to live together. Greed and avarice have no place in the schemes of life. The leader today must, from his own bigness, understand the frailties of those whom he leads. He must be willing to subjugate his own desires to the larger problems on hand.

*"The Guy In The Glass"*

You may hurry along in your struggle for wealth,
And the world make you 'king for a day';
But you'll stop now and then for a look at yourself,
And see what the "guy" has to say.

It isn't your Mother, or Sister, or Dad
Whose judgment upon you must pass—
The one who will call you a prince or a cad
Is the one looking back from the glass.

You may fool the whole world down the pathway of years
And get pats on the back as you pass;
But your final reward will be heartache and tears
If you cheated the guy in the glass.

Leadership can only be attained by a proper appreciation of human relations. The leader who would lead must be imbued with the idea of service based on the simple truth, said by the greatest of all salesmen, "Let him who would be greatest among the first be your servant."

# Torque Converter

BASED ON PAPER* BY

**A. H. Deimel**

Spicer Mfg. Division
DANA CORP.

BECAUSE hydraulic transmissions provide infinitely variable ratios, they have attracted wide automotive engineering interest.

A piston and cylinder pump, with a corresponding piston and cylinder motor was the earliest conception of a hydraulic transmission. Speed variation and torque multiplication was controlled by varying the pump or motor stroke, or both. This hydrostatic device has been successful in small power ranges, but high powers and speeds involve difficult problems because extremely high fluid pressures are required.

Another method, the hydrokinetic system, transmits power by the velocity of the fluid, rather than by fluid pressure. Direction flow of the high velocity fluid is changed by suitable blading. The torque is exerted by this change in direction.

Simplest of this type of transmission is the hydraulic coupling, a two member device where the input or driving member gives velocity to the fluid by centrifugal force and the fluid hits blades of the driven member. But it does not multiply torque. Speed reduction is simply slip or loss.

Adding stationary reaction blades to the device introduces a point of leverage, which enables it to increase or multiply the transmitted torque. This is a hydraulic torque converter. More stages of turbine and reaction blading make it a two- or three-stage torque converter.

Characteristics of torque converter performance depend upon details of blading design, but they all have these qualities:

- Torque multiplication increases with speed reduction between input and output. When the output shaft is held stationary it is in stall. Here input power is loss because no useful work is done.

- As load on the output shaft is reduced, it will start to rotate, the losses will drop, because useful work is now being performed by the output.

- Soon a speed ratio is reached at which losses are at a minimum for the particular converter.

- As the output load is further reduced, output speed increases and the speed reduction across the converter drops.

- Finally, by removing all output load, speed reduction reaches a minimum, the output shaft attaining its highest speed for any given input speed. This is known as racing and all input power is converted to heat or loss because no output power is being produced.

Hydraulic torque converters have only a certain range of operation because considerable power is needed to drive the input even when there is no output load. For operation beyond this range a separate mechanical drive through the unit must be made for speeds beyond which no torque multiplication is produced.

Thus at high vehicle speeds the hydraulic section is at rest and power is transmitted by the direct drive shaft with a minimum loss.

Converters are designed to operate with minimum losses at a given speed ratio. The blading is so designed that at this speed ratio the fluid enters the blades at the best angle with the smoothest flow. As the speed ratio changes the relative angles of fluid flow change, and the losses increase.

Variation of input speed with variation of output speed under constant input torque is another characteristic of the converter.

Blading can be designed to hold the engine speed more or less constant over the whole range of output speed, which is useful with inflexible engines which should be operated at constant speed.

### Designer Has Choice

On the other hand, the blading can be designed in such a way to handle increased engine speeds. Operation with optimum performance is spread over a wider band of speed.

High torque multiplication at the start, with engine held to a relatively low rpm, results in a rapid getaway, and the operation quickly comes to favorable speed ratios when the engine accelerates with the vehicle to produce a wide range of operating speeds.

In tanks, tank destroyers, and other military vehicles which faced heavy going, the value of the torque converter over gear box transmissions was amply proved. Often with the latter the vehicle came to a stop before shifting into the next high gear could be accomplished.

Enough is known about converter design today to permit accurate prediction of performance. This makes possible studies of the effect of variations in engine performance, axle ratios, weights, and the advantages of possible modifications of converter characteristics and performance to obtain the suitable overall design for any given purpose.

* Paper "Torque Converter Performance" was presented at SAE National West Coast Meeting, San Francisco, Aug. 19, 1948.

# PERFORMANCE

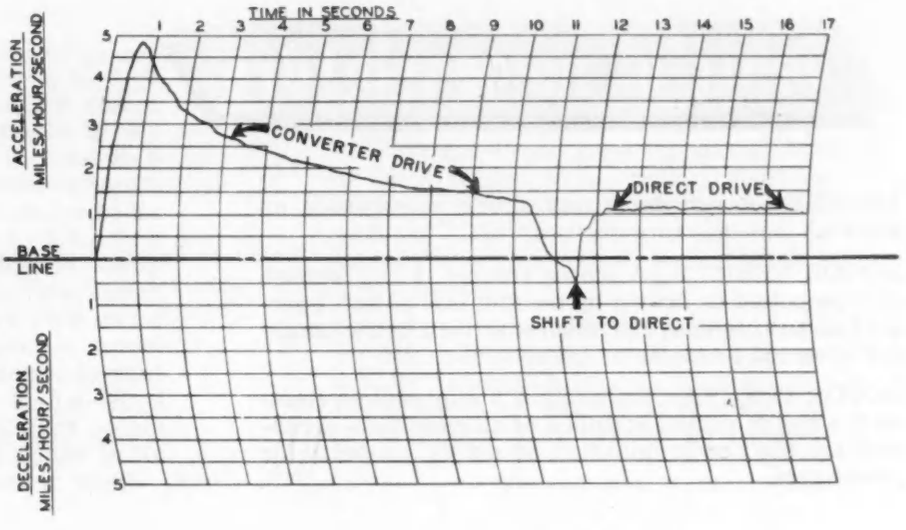
TIME IN SECONDS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
ACCELERATION MILES/HOUR/SECOND
5 4 3 2 1
CONVERTER DRIVE
DIRECT DRIVE
BASE LINE
SHIFT TO DIRECT
DECELERATION MILES/HOUR/SECOND
1 2 3 4 5

Fig. 1. Accelerometer diagram of 36-passenger city bus starting from stall shows peak near mph per sec, dropping to about 1½ when shifting into direct drive and leveling off to a little over 1 mph per sec within 12 sec from stall start

Converters have found its most ready acceptance in city bus service where frequent stopping and starting and continuous gear shifting results in driver fatigue and short clutch life. Mechanical transmissions are becoming a thing of the past.

Public appreciation of torque converters in passenger cars will grow rapidly, as motorists will readily appreciate its advantages, particularly through rush hour traffic jams.

### Advantage in Shifting

One interesting advantage of the converter is found in making a shift to a higher gear ratio behind a hydraulic torque converter.

With the conventional gear box often a grade must be climbed in low because of the difficulty of making the next shift up. With a converter a shift up behind the hydraulic device puts more load on the output shaft, increasing the speed reduction, and thereby the torque ratio across the converter, Fig. 1.

Thus a shift to a higher gear behind the converter does not correspondingly reduce the torque multiplication of the whole drive, and the vehicle can accelerate, even if considerable speed has been lost during the shift.

With its rotating input, output, and stationary reaction member, the torque converter is a rather simple three part device. But its design and calculation is exceedingly complex, principally due to the need for recirculating the fluid.

The reason the pump cannot be put on the engine and the turbine put on the axle is that as much as 5000 gal of fluid must be handled every minute at times in a bus converter. The essential feature of hydrokinetic couplings and converters is that the fluid flow is directly from the input to output with minimum energy loss. Both units are combined in a common case.

The high velocity of fluid flow requires fluids of low viscosity. Inhibitors against oxidation, sludging, foaming, and corrosion have been satisfactory.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

# SAE STANDARD

# COMMERCIAL

## vehicle nomenclature

**VEHICLE**—A vehicle is any single conveyance on wheels.

**MOTOR VEHICLE**—A motor vehicle is any vehicle self-propelled or drawn by mechanical power, operated on the highways or natural terrain in the transportation of property or passengers.

**MOTOR VEHICLE CHASSIS**—A motor vehicle chassis is a motor vehicle stripped of all essentials necessary for the accommodation of driver, property, or passengers.

**4 × 2**—A 4 × 2 motor vehicle is a two-axle motor vehicle equipped with four wheels, two of which are driving wheels.

**4 × 4**—A 4 × 4 motor vehicle is a two-axle motor vehicle equipped with four wheels, all of which are driving wheels.

**6 × 2**—A 6 × 2 motor vehicle is a three-axle motor vehicle equipped with six wheels, two of which are driving wheels.

**6 × 4**—A 6 × 4 motor vehicle is a three-axle motor vehicle equipped with six wheels, four of which are driving wheels.

**6 × 6**—A 6 × 6 motor vehicle is a three-axle motor vehicle equipped with six wheels, all of which are driving wheels.

Note: Motor vehicles designed with other combi-

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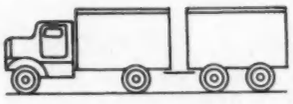
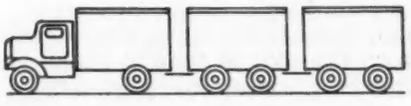
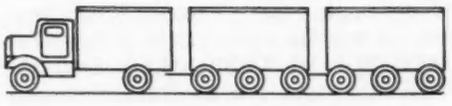


1. Two-axle truck with two-axle full trailer in combination



2. Two-axle truck with two two-axle full trailers in combination

3. Two-axle truck with three-axle trailer in combination



4. Two-axle truck with two three-axle full trailers in combination

***This standard for commercial vehicle nomenclature and for identification of motor vehicle combinations recently was approved for inclusion in the 1949 SAE Handbook. It was developed by the SAE Motorcoach and Motor Truck Technical Committee.***

# Vehicle Nomenclature

nations of driving and nondriving axles are defined in the same numerical order.

MOTOR TRUCK—A motor truck is a single self-propelled motor vehicle carrying its load on its own wheels and designed for the transporation of property.

TRUCK TRACTOR—A truck tractor is a motor vehicle designed primarily for drawing truck trailers and constructed so as to carry part of the weight and load of a semitrailer.

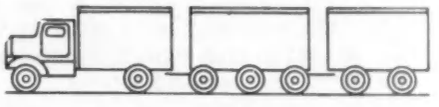
CONVENTIONAL TRUCK OR TRUCK TRACTOR—A conventional motor truck or truck tractor is one with the driver's compartment and controls located at the rear of a hood-enclosed powerplant.

CAB FORWARD TRUCK OR TRUCK TRACTOR—A cab forward motor truck or truck tractor is one with the driver's compartment and controls located forward of their position on the conventional front end type of motor truck or truck tractor.

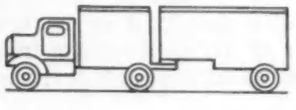
OFF-HIGHWAY MOTOR VEHICLE—An off-highway motor vehicle is any motor vehicle designed primarily for transporting property on natural terrain and may be of such size or weight as to be re-

## vehicle combinations

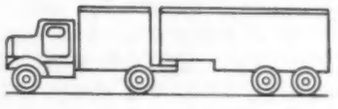
5. Two-axle truck with one three-axle and one two-axle full trailer in combination



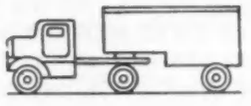
6. Two-axle truck with single-axle semitrailer in combination

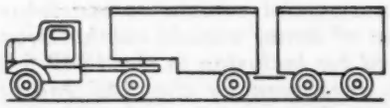


7. Two-axle truck with two-axle semitrailer in combination

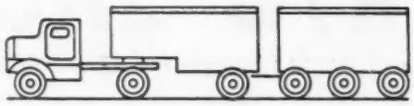


8. Two-axle truck tractor with single-axle semitrailer in combination

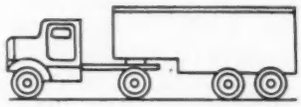




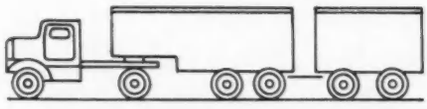
9. Two-axle truck tractor with single-axle semitrailer and two-axle full trailer in combination



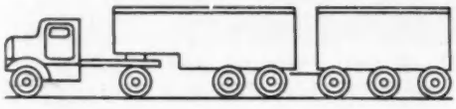
10. Two-axle truck tractor with single-axle semitrailer and three-axle full trailer in combination



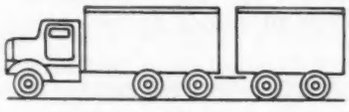
11. Two-axle truck tractor with two-axle semitrailer in combination



12. Two-axle truck tractor with two-axle semitrailer and two-axle full trailer in combination



13. Two-axle truck tractor with two-axle semitrailer and three-axle full trailer in combination



14. Three-axle truck with two-axle full trailer in combination

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stricted from operation on highways by state laws or regulations.

MULTI-STOP DELIVERY TRUCK—A multi-stop delivery truck is one equipped with a fully enclosed body with driving compartment integral and especially designed for quick and easy ingress and egress.

GANTRY TRUCK—A gantry truck is a motor truck so designed and constructed that it straddles the load to be transported and by means of an appropriate mechanism picks up the load and supports it during transportation.

MOTOR BUS—A motor bus is a single self-propelled motor vehicle designed for the transportation of ten or more passengers.

CITY TYPE MOTOR BUS—A city type motor bus is a motor bus designed to accommodate the maximum number of passengers, both seated and standing within the body space.

SUBURBAN TYPE MOTOR BUS—A surburban type motor bus is a motor bus designed primarily for maximum passenger seated load and equipped with overhead parcel racks.

INTER-CITY TYPE MOTOR BUS—An inter-city type motor bus is a motor bus designed for long distance transportation of passengers, with provision for the accommodation of their baggage.

TROLLEY BUS—A trolley bus is a motor bus electrically powered from overhead wires.

SCHOOL BUS—A school bus is a motor bus equipped to carry school children.

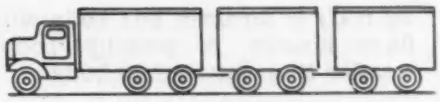
TRUCK TRAILER—A truck trailer is a motor vehicle with or without auxiliary motive power, designed to be drawn by a motor vehicle.

SEMITRAILER—A semitrailer is a truck trailer equipped with one or more axles and constructed so that a substantial part of its weight and load is carried by a truck tractor.

FULL TRAILER—A full trailer is a truck trailer constructed so that practically all of its weight and load rests upon its own wheels.

DUMP TRAILER—A dump trailer is a truck

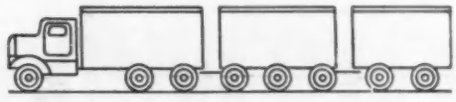
15. Three-axle truck with two two-axle full trailers in combination



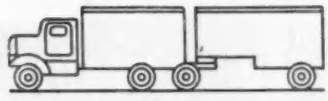
16. Three-axle truck with three-axle full trailer in combination

17. Three-axle truck with two three-axle full trailers in combination

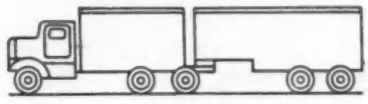
18. Three-axle truck with one three-axle and one two-axle full trailer in combination



19. Three-axle truck with single-axle semitrailer in combination



20. Three-axle truck with two-axle semitrailer in combination



## vehicle nomenclature

trailer provided with a body that can be tilted or otherwise manipulated to discharge its load by gravity.

LOW-BED TRAILER—A low-bed trailer is a truck trailer equipped with or wihout a platform body and constructed to provide a low loading height and designed for the transportation of extremely heavy or bulky property.

TANK TRAILER—A tank trailer is a truck trailer designed for the transportation of fluid commodities in bulk.

PASSENGER TRAILER—A passenger trailer is a truck trailer designed primarily for the transportation of passengers.

POLE TRAILER—A pole trailer is a truck trailer without auxiliary motive power, designed to be drawn by a truck or truck tractor and attached by means of a reach, or pole, or by being "boomed," or otherwise secured to the drawing motor vehicle and intended for transporting long or irregularly shaped loads such as poles, logs, pipes, or structural members, which are capable generally of sustaining themselves as beams between supporting connections.

Note: Wheel and axle complement — Two wheels are considered the complement of any axle regardless of whether they may be single or dual tire equipped.

SINGLE-AXLE TRUCK TRAILER—A single-axle truck trailer is a truck trailer equipped with one axle and two wheels.

TWO-AXLE TRUCK TRAILER—A two-axle truck trailer is a truck trailer equipped with two axles and four wheels.

THREE-AXLE TRUCK TRAILER—A three-axle truck trailer is a truck trailer equipped with three axles and six wheels.

TRAILER-CONVERTER DOLLY—A trailer-converter dolly is an auxiliary axle assembly equipped with a lower fifth wheel half, drawbar, and other necessary parts designed to convert a semitrailer to a full trailer.

BODIES

PICK-UP BODY OR EXPRESS BODY—A pick-

up body is an open box body with or without flare boards. A pick-up body is usually smaller than an express body.

SEDAN DELIVERY—A sedan delivery is a passenger car sedan type body adapted to commercial use.

PANEL BODY OR VAN BODY—A panel body or van body is a fully enclosed body. A panel body is usually smaller than a van body.

OPEN VAN BODY—An open van body is a body consisting of a platform and permanent solid front and sides with or without doors or tailgate and without a permanent top.

PLATFORM BODY—A platform body is a body without raised sides or covering.

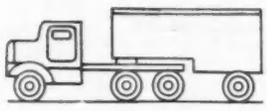
STAKE BODY—A stake body is a platform body with readily removable stakes which may be tied together with chains, slats, panels, and so forth.

RACK BODY—A rack body is a platform body with slatted sides to contain the load.

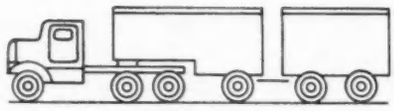
DUMP BODY—A dump body is a body that can be tilted or otherwise manipulated to discharge its load by gravity.

TANK BODY—A tank body is a body designed for the transportation of fluid commodities in bulk.

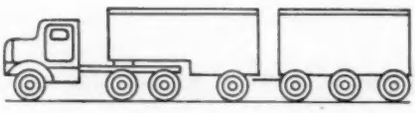
## vehicle combinations



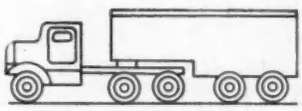
21. Three-axle truck tractor with single-axle semitrailer in combination



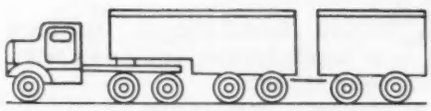
22. Three-axle truck tractor with single-axle semitrailer and two-axle full trailer in combination



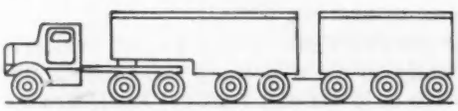
23. Three-axle truck tractor with single-axle semitrailer and three-axle full trailer in combination



24. Three-axle truck tractor with two-axle semitrailer in combination



25. Three-axle truck tractor with two-axle semitrailer and two-axle full trailer in combination



26. Three-axle truck tractor with two-axle semitrailer and three-axle full trailer in combination

NOTE 1: Two wheels are the complement of any axle regardless of the number of tires—whether singles, duals, or more.

NOTE 2: Trucks and tractors may be either 4 x 2, 4 x 4, 6 x 2, 6 x 4, or 6 x 6. Additional combinations are possible by other wheel or axle arrangements.

# FITTING FLUIDS To The TORQUE CONVERTER

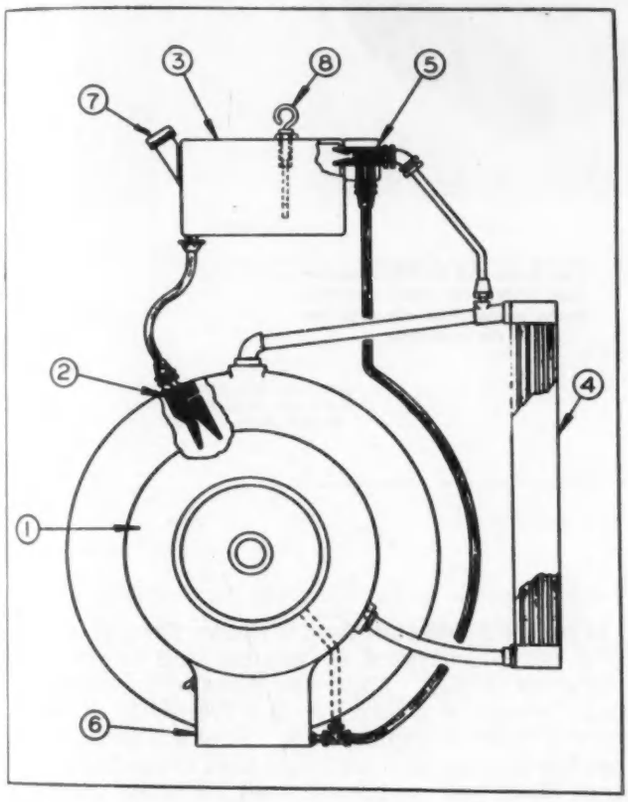



Fig. 1—First torque converter fluid system injected kerosene or fuel oil into the converter. Components shown are: (1) turbine, (2) injector, (3) supply tank, (4) cooler core, (5) aspirator, (6) sump tank, (7) filler cap, and (8) dip stick

EXCERPTS FROM PAPER* BY

**E. F. Collins**

GMC Truck & Coach Division

DEVELOPMENT of torque converter fluids and fluid systems helped make this new type of transmission more generally accepted as an efficient means of transmitting power in urban coaches. Only after evolution of the present torque converter fluid system did researchers have a basis for perfecting a more stable, better-lubricating fluid.

The first torque converter fluid system was a separate system, used with both gasoline and diesel engines. This system, shown in Fig. 1, used the jet principle in that fluid received from supply tank was injected into the converter, thereby maintaining supply of fluid. An aspirator was used to return fuel from bottom of converter to supply tank. Fluid used was fuel oil or kerosene.

### System Drawbacks

This separate system was effective, except that difficulty with cavitation or bubbling was experienced. In an attempt to remedy this, a small percentage of SAE 30 engine oil was used. While this was somewhat effective in some of the milder operations, it was of little avail in the severe operations. Added to the cavitation difficulty were the factors of fluid breakdown and deposits.

To use up the fluid before breakdown or deposit

* Paper "Some Considerations of Present Day Torque Converter Fluids and Torque Converter Maintenance," was presented at SAE Pittsburgh Section meeting in Oil City, May 21, 1948.

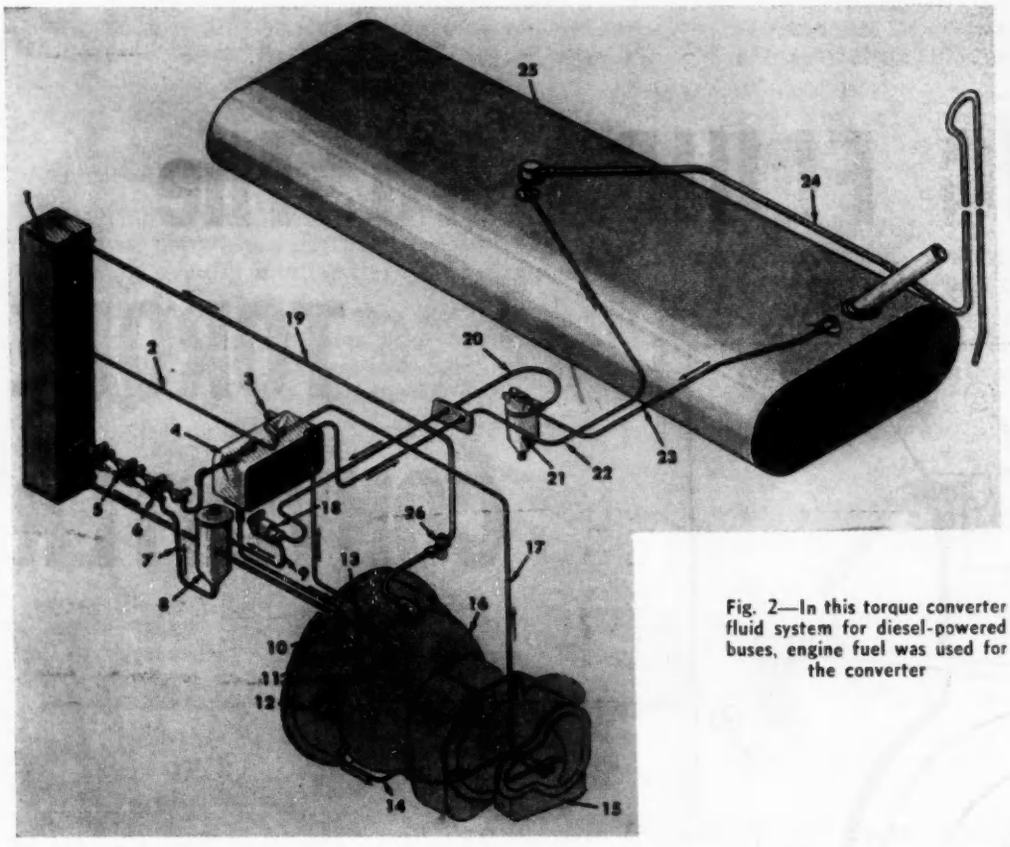



Fig. 2—In this torque converter fluid system for diesel-powered buses, engine fuel was used for the converter

formation could occur, a combination system was designed wherein the same fluid, as used in the engine for power, was used in the torque converter for power transmission. This system is shown in Fig. 2.

In the combination system the fuel pump draws fuel from the fuel tank through a primary filter, which is further directed through a secondary filter to diesel engine injector rack or manifold. Being a constant-pressure flow, fuel not immediately used in the engine is returned to the supply tank. From the supply tank fuel flows to converter, the excess again returning to the supply tank. Excess fuel from supply tank is returned to the fuel tank. Fuel from the converter also flows from top of turbine to a cooler through pressure restriction and returns to turbine in continuous circulation.

### Fuel A Good Fluid

This system offers the advantages of constant refreshening of the converter fluid and of using one material for engine power and hydraulic power transmission. The system is still in use with a considerable number of coaches.

The combination system solved a number of problems in power transmission for the diesel-hydraulic coach. However, since the gasoline-powered coach problem still remained, it was necessary to design and redesign until a more effective system was available for the gasoline-hydraulic coach. Hence, the present separate system shown in Fig. 3, was accordingly introduced.

It will be noted that fluid is drawn through a filter by a pump activated by engine, and is then delivered to turbine. Fluid also flows by turbine pressure through a cooler. A line from top of cooler returns fluid to supply tank. It will also be noted that the injector and aspirator have been eliminated. Since there was no special fluid generally available for use in the separate system, fuel oil was continued in torque converters using this later design; some with the somewhat questionable aid of 5% engine oil. Also, with other operational problems contingent upon any new device, the effect of fluid was possibly masked off.

Many operators operated successfully with kerosene. Others began to have difficulties with high fluid consumption, vaporization, cavitation, and oxidation caused both heavy varnishing of turbine parts and collection of heavy deposits in lines, filters, and supply tanks. Rusting and corrosion also were experienced.

It was found that a heavier product, generally available and of viscosity slightly above that of diesel fuel oil, would eliminate most of the difficulties without impairing efficiency of the unit. Coach operators were soon using a product known as "Mineral Seal oil" or "300 Burning oil." Since this oil is of general specifications, quality differs appreciably in different parts of the country so that results obtained using some of these Mineral Seal oils were not encouraging. Some of these resulting conditions are shown in Fig. 4. A possible conclusion as to why oxidation products collected in the

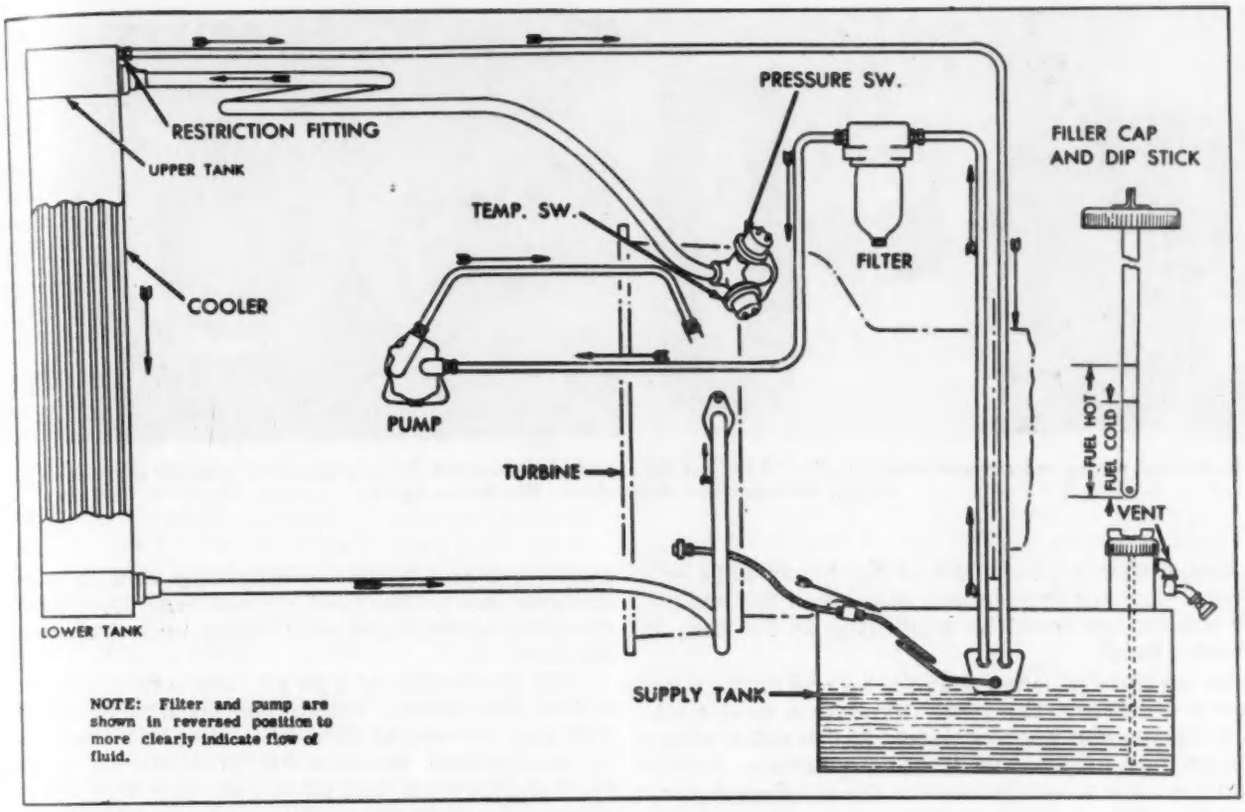



Fig. 3—Current torque converter fluid system

supply tank is that the tank is the coolest point in the system, and oxidation products, soluble in hot fluid, become insoluble at this point and settle out.

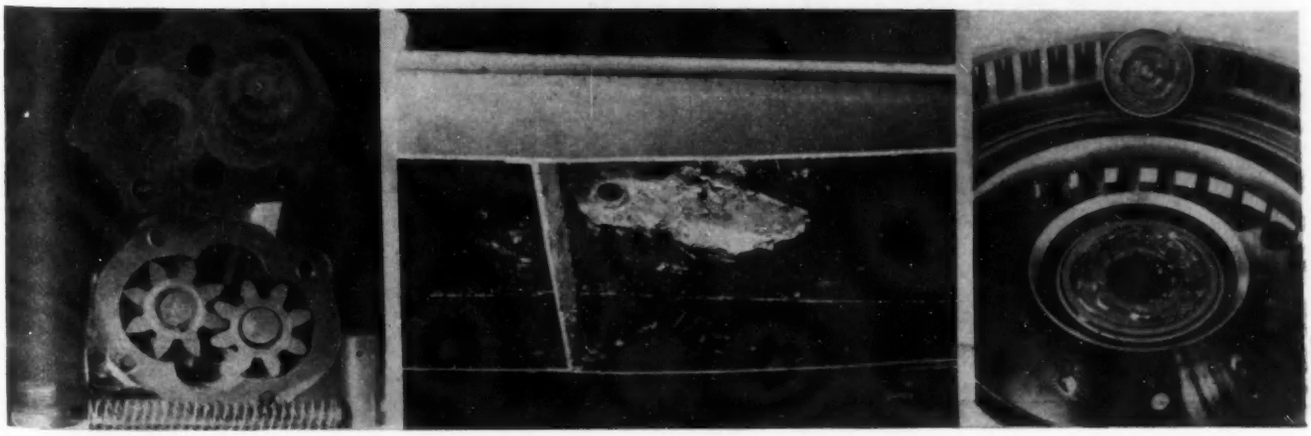
Recognizing that all Mineral Seal oils apparently did not provide stability, rust proofing, and lubrication qualities desired in a torque converter fluid, we started a preliminary program of investigation into various types of oils. Since no desirable oil-type was readily available for test, it was necessary to "start from scratch."

A long term program of investigation including considerable laboratory testing and thousands of test miles on the road was carried out over a period of about five years. This program was rather fruitless—except that we probably learned what was necessary, although it was unobtainable. The results of tests were usually that either the oil did not have the oxidation resistance and other desirable properties, or it was of a type not likely to be made generally available.

Finally, with the cooperation of an oil company representative, a light spindle oil of Pennsylvania base[1] was selected, to which was added a certain percentage of heavy-duty engine oil additive. It

[1] It was subsequently shown that spindle oils from other crudes, plus suitable additives, gave equally good results.

Fig. 4—Deleterious effects of Mineral Seal oils on components of the torque converter installation



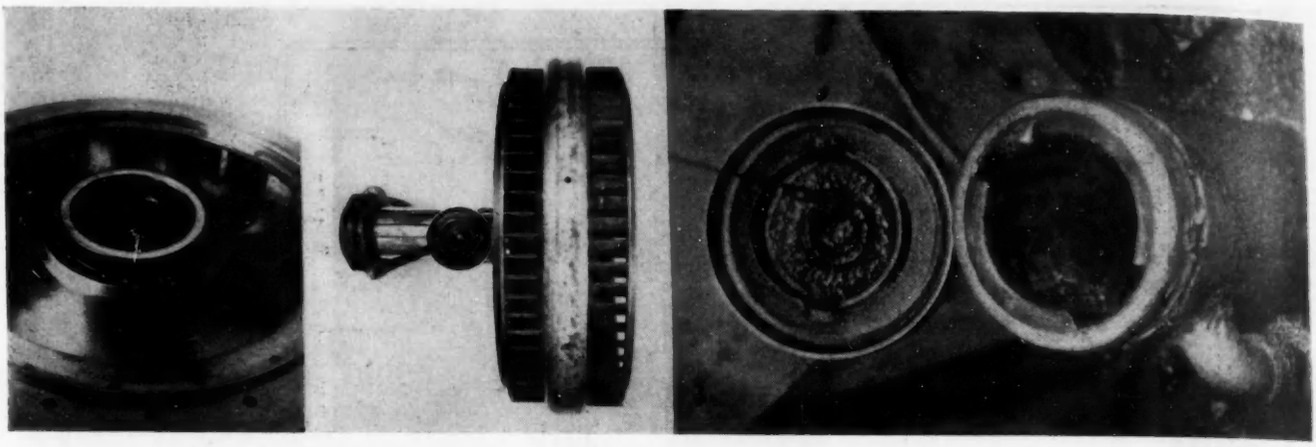


Fig. 5—Sticking, rusting, and corrosion were just a few of the troubles caused by Mineral Seal oils, as evidenced by condition of the pump wheel, rotor, and supply tank shown above. Now look at Fig. 6

was hoped that with the use of the heavy-duty engine oil additive, the excellent showing of the heavy-duty engine oils could be duplicated in the torque converter fluid.

After we were satisfied that the oil was of the type believed necessary, the next step was a field trial. The fluid was run approximately 25,000 miles without change in an average "tough" operation, where it had been the usual practice to drain Mineral Seal oil every 6000 to 9000 miles, and to clean filter every 2000 miles.

At the conclusion of this test, torque converters using both the new additive type material and the Mineral Seal oil were dismantled and inspected. All indications at this inspection pointed to the superiority of additive type fluids. With Mineral Seal oil, fluid filter was plugged, pump bypass valve stuck; and there was considerable corrosion of turbine pump and rotor as well as appreciable rusting in supply tank, cap, and filler neck. Also, seal diaphrams had hardened somewhat and oil sample analysis showed heavy oil breakdown. Condition of the pump wheel, rotor, and supply tank are noted in Fig. 5.

With the additive type oil, the torque converter system was clean. There was no sign of internal corrosion or rust, system was clean and there were no appreciable break-down products in the oil. Fluid pump, seals, and filter were in very good condition. Fig. 6 shows condition of some of the parts at the inspection of converter using additive type fluid. These field tests have been duplicated with a number of similar products, and the results have been very good.

## Fluid Evaluation

Since we have seen the results of tests using the new fluid, and the apparent advantages involved, it may be well to consider torque converter operation or design factors, which apparently make certain fluid properties or characteristics neces-

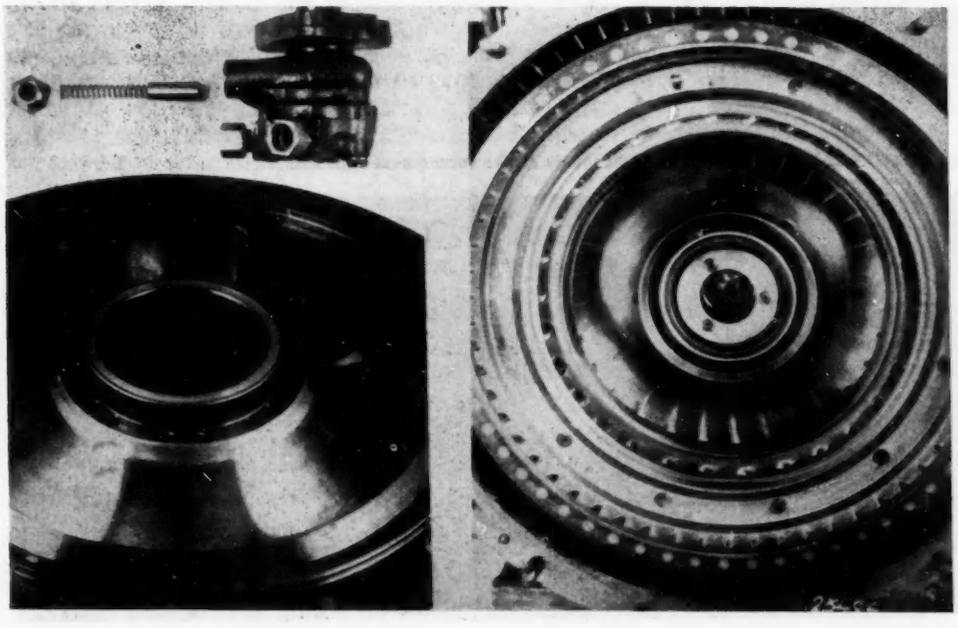


Fig. 6—Additive type fluids produced good results, inspection of these converter parts indicate

sary. The properties at present believed to be desirable in the fluid are as follows:

• *Viscosity*: In the consideration of viscosity, two factors appear to be important: (1) the effect on efficiency and (2) effect on lubrication of seals and fluid pump. It has been said that greatest efficiency in the Lisholm—Smith converter can be obtained with the thinner but heavier fluid, such as water. This probably precludes the fact that there are certain points to be lubricated. Also, water would allow rusting and boiling. Stability, of course, is important. Thus viscosity selected probably represents a compromise between the factors of efficiency, lubrication, and fluid stability. However, since the matter of converter efficiency is one for a hydraulic engineer, we can probably pass the item of viscosity by noting that in the tests completed an oil of 55 to 65 SUS at 100F appears to satisfy requirements.

A study of the effect of viscosity index in these fluids is of interest when it is considered that: if the torque converter operates more efficiently on thinner fluids, the more the fluid thins out at operating temperatures, the greater should be the efficiency obtained. This is mainly conjecture, of course, and it may be found that it would be necessary to sacrifice stability or other factors for more efficiency. For instance, the lower viscosity index oils may attack the seals more than the higher viscosity index oils. Therefore, other properties associated with viscosity index (such as flash point, volatility, pour point, and effect of fluid on the seals) must be studied, and further work done on all of these points before any positive statements in connection with viscosity index can be made.

• *Flash Point and Volatility*: Flash point is important as it provides some indication of the volatile nature of the product as well as an indication of the possible fire hazard in storage, or in vehicle lines. Indications of volatility are necessary to forecast whether trouble may be expected with cavitation or bubbling in the converter system. We have found that in the viscosity range of 55 to 65 SUS at 100F, volatility is quite likely to run 400 to 700F (as determined by ASTM method D158-41, Distillation test). This apparently provides an adequate margin of safety, since the converter normally operates at 200 to 250F maximum.

• *Antirust and Anticorrosion Properties*: The need for the antirust and anticorrosion properties in the fluid is quite obvious when it is considered that heavy rust and corrosion products, as well as the chemical activity involved can go far towards plugging circulation and damaging system parts. The rusting of steel turbine parts and supply tank also corrosion and loosening of brass blades are some of the problems encountered.

To get some check on these properties a 48-hr humidity cabinet test conducted on steel panels, previously dipped in the sample, provides some interesting indications. Primarily a rusting test, it also checks corrosive nature of additive in the presence of water. Fig. 7 is indicative of protection provided with additive type oils. Panel 10 was run with additive type oil, Panel 11 with straight mineral oil.

• *Miscibility Tests:* Since it is necessary to know whether the sample will be miscible and compatible with other fluids, some indication of this property should be sought in the laboratory. Indications of the effect of one fluid refined from one type of crude, on another fluid refined from a different crude, are of interest—especially if certain oil break-down products are present in one or the other of the fluids. Any activity between additives is also of interest.

• *Foam Test*: Of course foam can be damaging in a hydraulic system. Hence the presence or absence of foaming tendency of these fluids is of interest.

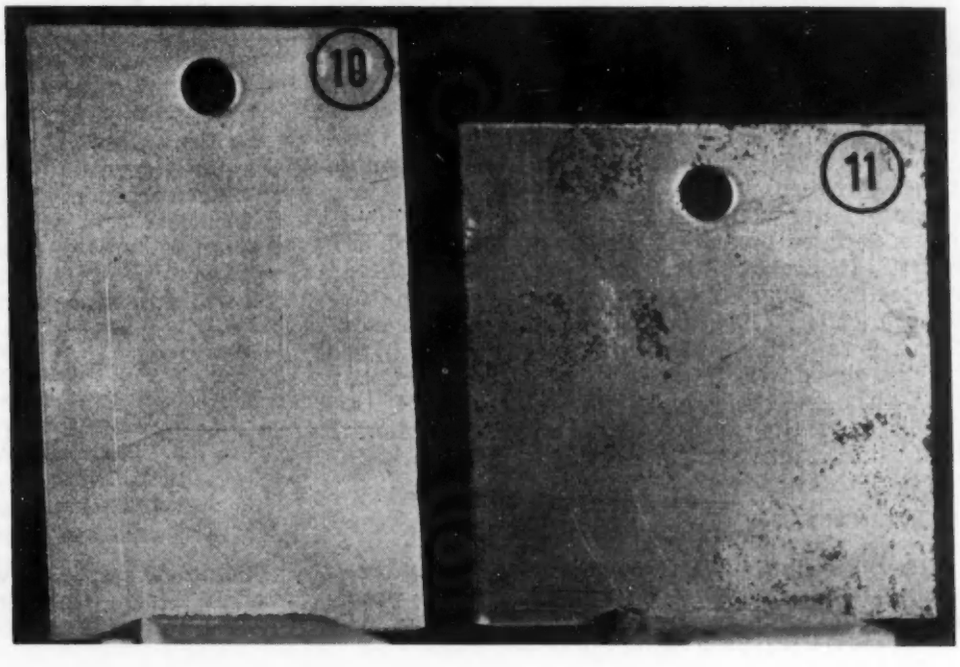



Fig. 7—Both rust- and corrosion-inhibiting properties of straight mineral and additive type oils are indicated by the appearance of these steel panels after a 48-hr humidity cabinet test. No. 10 was dipped in additive type oil, No. 11 in straight mineral oil prior to the test

• *Pour Point*: Oils which thicken excessively at low temperatures can impair the operation of a torque converter by channeling of the oil, allowing little or no fluid flow. Possibly there is some substituting of solid friction for fluid friction. In a few cases enough resistance has been present to shear turbine blades. However, in our experience, pour points of approximately –10F or below appear to be satisfactory.

• *Effect on Turbine Seals*: It is necessary that the effect of the fluid on the synthetic rubber seal diaphrams is known since, if the fluid extracts the plasticizer contained in the synthetic rubber, it becomes hard, and sealing action of the carbon ring is destroyed. Seals are heated in the fluid for extended periods up to 300F, with periodic examination of hardness and flexibility. Seals which have not hardened appreciably at 70 hr of this treatment are generally considered acceptable.

The development of seals and torque converter fluids joins in this connection; we are continually attempting to answer the problem or problems as to whether poor results obtained with a seal are due to the seal being too easily affected by a good oil, or due to the oil being too active in its action on the seal. This characteristic, however, does not appear to be critical in the fluids as presently used, as they apparently have little effect on the synthetic rubber diaphrams.

• *Cleanliness in Operation*: All of us—oil supplier, equipment manufacturers, and operators alike—are interested in cleanliness of operation. Particularly with reference to engine, torque converter, rear axle, or other assemblies, it generally means absence of foreign material which might, in one way or another, cause failure of the unit. Hence, it is believed that the detergency, dispersancy or cleanliness property, is important. It is that property which holds foreign matter in suspension until it can be filtered out or drained out with the oil.

• *Oxidation Stability*: Since the system is independent and receives no continuous supply of refreshing fluid, the property of resistance to oxidation is of prime importance.

This resistance to oxidation is checked in the laboratory using the Underwood oil circulation apparatus, and also with the use of the CRC L-4 engine test. The L-4 test is modified to an oil temperature of 250F to duplicate more closely temperature of the converter. Since the L-4 test is conducted under controlled conditions, it provides a more definite means of measuring oxidation stability. It probably is more reproducible than a service test, which may be more severe in one fleet than another. The correlation between the modified L-4 test, the Underwood test, and actual field service appears to be quite good. Results indicate that although the engine test, in practicality, has no direct relation to torque converter operation, it is of value in providing an indication of the probable effectiveness of the oil in service.

## Field Test Procedure

When the fluid has passed the laboratory stage of testing, it is logical that we try to satisfy the proof-of-the-pudding side of our curiosity. The best means of doing this, in our opinion, is to put the fluid into a number of torque converters operating under actual service conditions. In tests of this sort it is desirable that the fluid is placed in new torque converters at the factory before delivery. In this way we are able to get the catalytic effect of new metal on the oil, eliminate possibility of contamination, check overall durability, as well as deposit formation if any.

These tests usually run approximately 25,000 miles, with follow-up and collection of data and samples once a month, for a period of about six months. One test was followed for approximately 50,000 miles and at the end of this period the oil was still in good condition, suitable for further service. On field test the fluid is used under usual operating conditions.

At the conclusion of the test period one or two converters using the test fluid are dismantled and inspected. Condition of seals, fluid filter, lines, pump and supply tank are noted.

The field test results with the fluids tested have been very gratifying in that most of the fluids gave excellent results. This probably indicates that we were able to predict, through laboratory testing, how an oil would behave on field tests.

Having reached the point where an acceptable fluid was developed, the next hurdle was the question of how to make this new fluid available to operators of torque converters. Numerous ideas, plans, and programs were explored; but it was finally concluded that it would be necessary to supply the fluid through our Service Parts Department. This was done until a short time ago, when a sufficient number of sources were developed so that a list of fluids meeting requirements could be issued.

## Maintenance

As most operators know, the best equipment or the best fuels and lubricants cannot be effective unless an adequate system of maintenance is in force. Preventive maintenance is fast becoming a science rather than a "grease monkey's" art, and in many cases has increased both service to customers and revenues. However, the extent of the maintenance program depends upon the individual operator, his operation, and various economic factors; hence no definite line can be drawn.

Maintenance of the torque converter has been aided considerably by the use of a stable fluid, since the fluid permits longer seal life, freedom from deposits, freedom from rust and corrosion, good lubrication, and serves efficiently as a means of power transmission. Maintenance suggestions that can assist in prolonging efficient life of the torque converter are as follows:

1. Maintain regular check on:
   a. Engine idling speed,
   b. Torque converter stall speed,
   c. Lines for leaks,
   d. Electrical system, and
   e. Adjustment of controls.
2. Lubricate bearings and rear case regularly.
3. Use only new type stable fluid.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

# Relationship of Section Size, Hardness, and Composition of GRAY CAST IRON

BASED ON PAPER* BY **R. G. McElwee,** Manager, Iron Foundry Division, Vanadium Corp. of America.

ADVANTAGES of wear resistance, resistance to heat shock, relatively high fatigue ratio, comparative ease of manufacture, machinability, and capacity for heat treatment justify the use of cast iron for more component parts of modern mechanisms.

Many difficulties in securing castings to meet conditions—in which design is necessarily complex—have resulted from a preconceived notion that we must have certain values comparable to other materials of engineering, when a thorough investigation would indicate these values are not only unnecessary but, in some cases, undesirable.

A case in point is modulus of elasticity. Many foundrymen have exhibited considerable pride in their ability to produce an iron approaching the modulus of steel, or 30 million psi. Gray iron is a rather poor conductor of heat and a high heat gradient can be built up in a casting, such as a brake drum, quickly.

If the inside of the drum reaches a temperature 700 or 800 deg higher than the outside, the tendency toward failure is teriffic if the iron is sufficiently stiff that the stresses generated by the heat cannot be relieved by the expansion of the outside of the casting. Here an iron of relatively low modulus permits a movement of one part against another without destruction. High graphite of low modulus iron contributes to higher deflections. The very lack of continuity of the matrix caused by graphite particles may also be a factor in stopping incipient heat cracks which are later causes of failure.

A very valuable property of gray iron as an engineering material is its damping capacity. This seems to be a straight line function of graphite content and again calls for a relatively high carbon iron in the specification if vibration is encountered in service.

Because the engineer ultimately must be concerned with relative economies of producing different types of iron, he should know that in specifying high tensile strengths and low total carbons, he is directly affecting the cost per ton of iron poured.

It has been the experience of the author that the percentage of yield can be improved from values as low as 65% to 85% by a better selection of iron composition. In most cases this improvement need not carry a penalty of casting strength, although test bars may give a misleading high value in the former case.

Naturally the higher total carbon iron will contain more graphite. Leakage does not occur through graphite particles. Instead the low carbon iron of low graphite under a given set of conditions will usually show a greater tendency to microporosity than a relatively high carbon iron made with the proper amount of silicon, even though the graphite particles are more numerous. It is this microporosity which is usually responsible for leakers.

The basis of selection, or percentage of each of these elements and their relationship to each other follows:

*Carbon,* until quite recently, was considered incapable of close control and therefore a wide range was assigned, or no definite limits were given. Adoption of ASTM specifications from Class 20 at 20,000 lb to Class 60 at 60,000 lb tensile led to selection of higher strength specifications to overcome difficulties of casting when the real remedy is to select an iron having properties other than higher tensile strength. This often produces sounder castings. Thus, producing castings less subject to casting strains, has solved many troublesome defects when selection of a higher strength value only accentuates the trouble.

Higher carbon levels mean lower shrinkage, higher deflection and, with a proper adjustment of silicon, can produce any reasonable strength and hardness. A more careful selection of carbon and silicon can easily affect economies of manufacture in the machine shop and foundry. Higher total carbon in-

* Paper "Section Size, Hardness, Composition Relationship in Gray Cast Iron" presented at SAE Summer Meeting, June 8, 1948.

volves higher graphitic carbon which is responsible for better performance in applications involving heat and wear resistance.

*Silicon* is the adjustment element in gray iron castings. Proper selection of the silicon range can make a casting of any reasonable hardness, assuming that the silicon selection considers the carbon level and the section size. The matrix can be kept pearlitic and the amount of graphite will depend upon the selection of carbon. Hard or white iron edges do not fall within this hardness control but represent a separate problem to be dealt with by a well-known and accepted technique of iron founding.

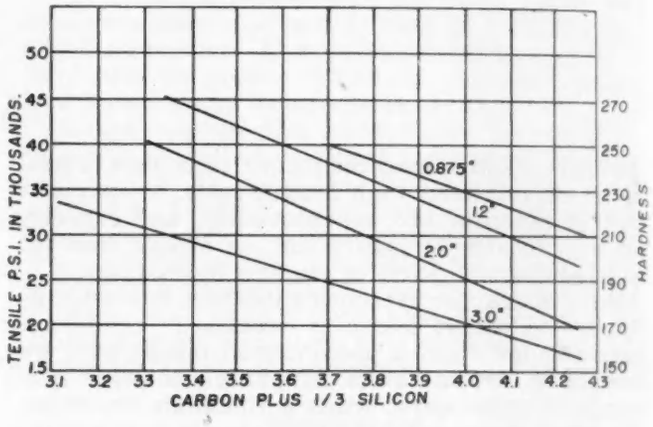
*Manganese* forms a compound with the sulfur which removes it from solid solution in iron and leaves it as inoffensive inclusions. Specifications of 0.60–0.80 are usual, and will fix sulfur provided the amount present does not exceed 0.15%. It is occasionally used in larger amounts for stabilizing pearlite without causing hard spots, but with some sacrifice of machinability.

*Sulfur* is unquestionably a necessary evil. This comes from the fuel and it is desirable to specify a maximum compatible with the available raw materials and methods of melting. This value is quite universally accepted as 0.12%.

*Phosphorus* in automotive castings should have a top limit of 0.20%. Where the design is necessarily intricate and the range of section broad, a lower value would be desirable. Excessive phosphorus tends to promote shrinkage. Formation of iron phosphide extends the period of freezing, some suspect.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

PHYSICAL PROPERTIES OF ROUND BARS.



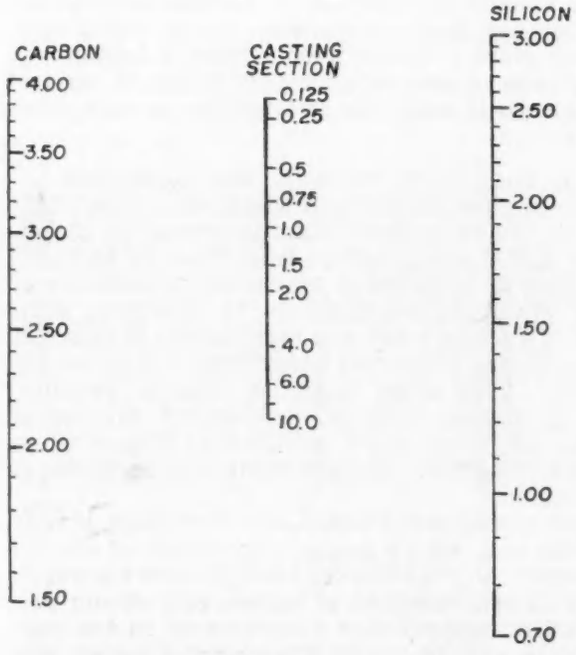

Example A: An iron showing 3.30 carbon and 2.10 silicon will have a carbon plus 1/3 silicon value of 4.00. This will be approximately 230 Bhn in a 0.875 bar and 170 in a 3 in. bar. This chart indicates sensitivity of iron to cooling rate. The tendency of iron to cast white at extremely high cooling rates has been ignored here, because chilled edges on castings should not be considered as variations in hardness of gray iron. Techniques have made it possible to cast relatively hard material in quite thin sections without the danger of white iron edges.

Curves presuppose the casting is entirely gray. In this region the relationship of hardness to cooling rate and composition can be quite accurately predicted.

Chill depth is related to moisture in the blast, relative volume of air, weight of coke, and other conditions of manufacture within control of foundrymen.

There is a limit beyond which castings should not be designed with the expectancy of complete absence from chill. A vane on the rotor of a water pump which has a right-angle corner and which is 3/32 in. thick, might be expected to show chill often enough to cause machining difficulty. A casting ⅛ in. thick, without sharp corners, if mold conditions are favorable, is feasible.

COMPOSITION - SECTION CHART FOR 200 B.H.N.




Example B: Suppose it is desired to make a casting 1 in. thick from an iron of 3.60 T.C. and obtain 200 Bhn. A line drawn from 3.60 T.C. through 1 in. section extends across 1.55 silicon which is the correct value, with the usual tolerance of ±0.10%. Chart constructed from a large number of experiences from many foundries and a wide variety of applications can be used to indicate average analyses that will produce a hardness of approximately 200 Bhn at the various thicknesses.

Example C: Suppose in B it is desired to reduce the hardness of 187. Control line crosses this at plus 0.20 silicon which when added to 1.55 (the value for 200 Bhn) gives 1.75 silicon as the correct value.

Correction to be made for an adjustment of hardness from the 200 level established by alignment chart, B.

Chart A has indicated relative hardness of the same iron in standard ASTM test bars, which are ⅞ in., 1.2 in., 2 in. and 3 in. in diameter.

Numerical values for various irons poured into accepted test sizes across the bottom of this chart are "carbon equivalent" and represent a convenient method for the foundryman to assign a single measurement to the carbon and silicon in iron for comparative purposes. It assumes that additional silicon will be one-third as effective as the same amount of additional carbon in their effect on structure and hardness.

Simple calculations establish that the cooling rate of a wall is approximately the same as a cylinder of twice the diameter. A 2 in. test bar will have the same hardness as a casting 1 in. thick. For practical purposes the 3 in. bar can be used as a pilot for castings 2 in. to 2¼ in. in thickness. In making heavier castings an arbitrary test bar which has been found experimentally to approximate the cooling conditions of the casting, is made.

Tension and other tests are made from one of the ASTM standard bars and in a great many cases the engineer and foundrymen have fallen into the error of using the 1.2 in. test bar for all sorts of work regardless of dimensions.

For any repetitive casting which is very critical it may be necessary to establish arbitrary test bar diameters on an experimental basis if reasonably close control is necessary.

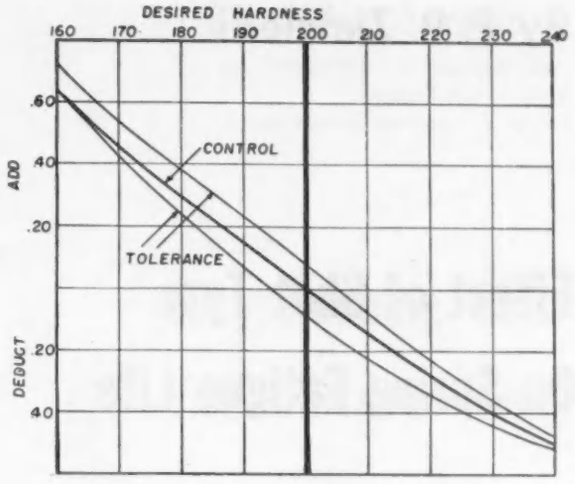
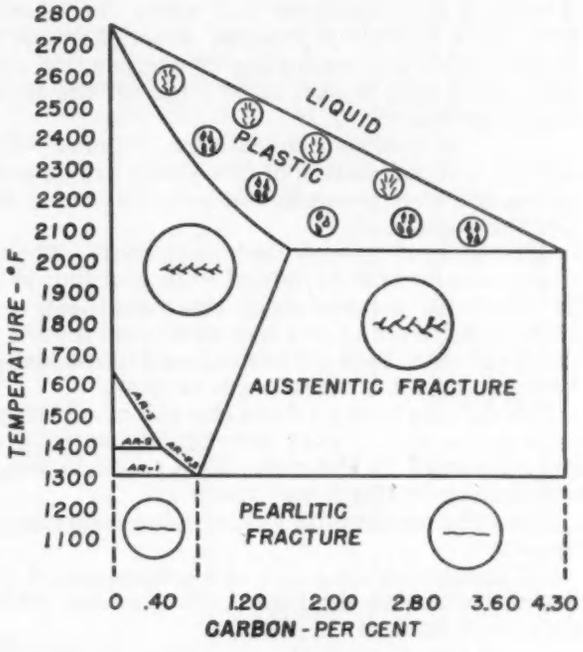



Chart D: Explains reason for selecting highest carbon comparable with minimum strength. Lower total carbon irons have a longer range of temperature from the time that they have ceased to be purely liquid until completely solid. In this plastic period many difficulties arise and the narrowing of this period is advantageous.

Shrinkage continues throughout this period, but iron "feeds" with great difficulty and small voids, microporosity, or open iron, may be generated. The narrower the plastic range the less tendency for this.

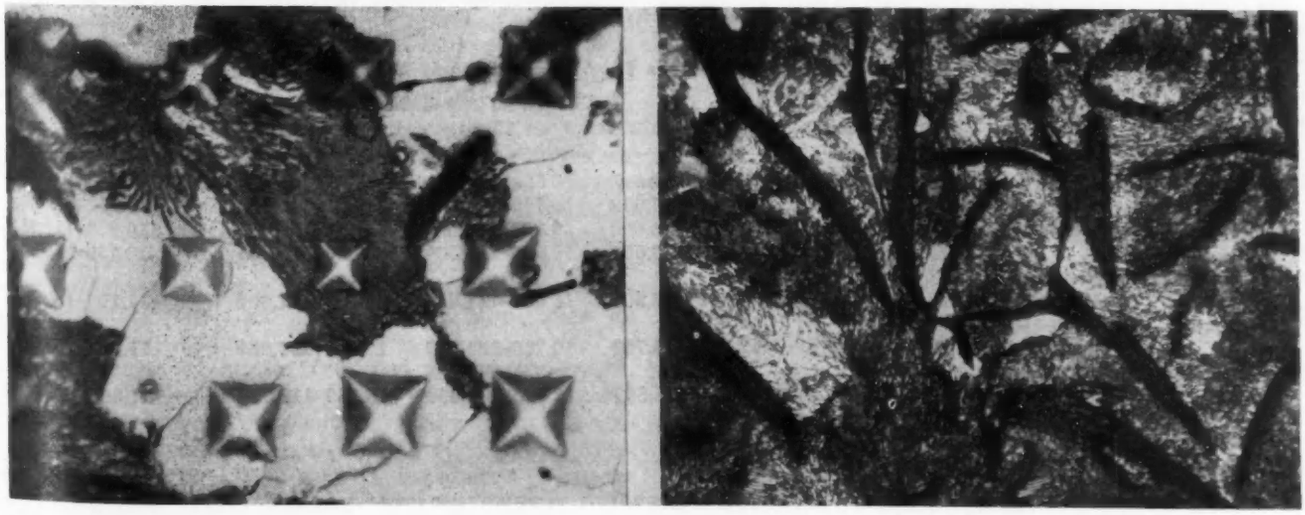
By using high total carbon, the same matrix structure and hardness can be obtained at higher carbon level as with lower carbon, if silicon is adjusted in opposite direction by amount indicated on alignment chart, B. There is a distinct economic advantage in running relatively high total carbons. Necessity for feeding with external risers is reduced, castings generally are sounder.




Below indicates the fallacy of attempting to regulate the performance of an iron with respect to wear on the Brinell basis. The iron used was 4.00 total carbon, showed Brinell of 146, yet the microhardness of the pearlite between the graphite particles fell in the range of 226 to 255. This is load carrying value of the iron. While this type of iron will show greater deformation under concentrated loads it is where unit pressures are below deformation point.

Often high graphitic irons show many times the life in resisting wear of lower graphitic irons of the same matrix structure.

Lower right shows iron structure predominately pearlite.



By F. P. Zimmerli
Chief Engineer,
Barnes-Gibson-Raymond
Division of Associated Spring Corp.

SHOT

# Effect of Shot Type On Spring Fatigue Life

**These articles are based on papers presented by Zimmerli and Straub at a recent meeting of the Shot Peening Division of the SAE Iron and Steel Technical Committee. The test results here interpreted are helping the SAE group in its quest for knowledge to get more out**

THIS investigation was undertaken to find out how various shot hardness will affect the endurance life. As a matter of interest, attempts were made to determine the possibility of overpeening springs even using shot known to be large for the wire size in the spring.

On all tests Almen strips were included with the springs. If correlation of the Almen arc height and spring life were possible, the tests run would establish this fact.

Six different lots of shot were used. These included one lot of P-46, one of P-28, and four of P-16. Of the P-16, one was steel, two were heat treated white cast iron, and one was white cast iron as were the P-46 and P-28. Physical and chemical tests were run on all of these types of shot.

The springs were all from one coil of oil tempered valve spring wire. They were coiled, heated, ground and processed at the same time so as to insure a consistently uniform test specimen.

From the test results we drew the following conclusions:

1. Throughout the range of hardness tested in the shot there was no significant effect on the ultimate endurance limit of the springs.

2. The size of shot did not affect the endurance limits within certain limitations; for instance, P-16 or P-28 shot gave comparable results. Shot P-46 on the 0.148 in. wire employed in the springs lowered the endurance limit.

3. These springs can be overpeened with the coarse P-46 shot. This was impossible under the same conditions with P-16 shot.

4. There is no relationship between arc height and endurance limit.

5. From breakdown tests it appears that shot life is inversely proportional to the hardness of the shot.

6. The smooth nonpeened appearance of samples using steel or soft shot will cause a departure from the usual inspection methods for peening.

### Fatigue Tests

After shot peening all fatigue machine springs were heated to 450 F for one-half hour. Then they were placed in the fatigue machine in sets of eight at such stress ranges that we could determine

Turn to p. 39

**Table 1—Endurance Limits of Springs for Various Periods of Shot Peening**

| Shot | Material | Hardness | Time of Shot Peening 15 min | 15 min | 30 min | 120 min |
|---|---|---|---|---|---|---|
| P-46 | White Cast Iron | Rockwell 65 C | less than 20,000-115,000 | 16,750-106,200 | 11,700-110,500 | 11,700-110,500 |
| P-28 | White Cast Iron | Rockwell 63 C | 14,200-123,600 | 3,300-110,000 | 12,600-120,000 | 10,930-113,750 |
| P-16 Lot 100 | Steel | Rockwell 34 C | 13,500-116,000 | 10,750-118,200 | 16,000-115,000 | over 12,750-120,500 |
| P-16 Lot 101 | Heat-treated White Cast Iron | Rockwell 62 C | 11,500-122,500 | 10,000-117,500 | 10,000-127,500 | 11,100-120,250 |
| P-16 Lot 102 | Heat-treated White Cast Iron | Rockwell 48 C | 12,300-123,750 | 10,750-125,800 | 13,000-120,500 | 11,000-119,200 |
| P-16 Lot 103 | Heat-treated White Cast Iron | Rockwell 26 C | 16,000-122,500 | 12,200-120,000 | 10,750-118,000 | 11,000-121,000 |

Note: Endurance limit not shot peened 20,000-95,000.

By John Straub
American Wheelabrator and Equipment Corp.

# PEENING

## Why Peening Calls For Uniform Shot

**of shot peening.**

**Based on his test results, Zimmerli sees variation in shot hardness influencing very little the endurance life of a peened part. Straub strongly urges uniformity of shot size and weight and shows how it makes for more economical production peening.**

I have long been enthusiastic about the importance of uniformity of shot size in a peening operation, particularly from the standpoint of removing broken shot from a peening machine as quickly as possible.

One of the most striking fatigue test comparisons is that in which specimens were peened with and without a high percentage of broken shot in the peening machine. This series of tests was run for the purpose of simulating the conditions which existed in a production peening machine. The production machine involved contained approximately 86% broken shot in the working material.

The following fatigue tests were made on flat specimens of 9260 steel, 40–45 RC with a thickness of ¼ in. and a width of 1⅛ in. in the region of maximum stress. The tests were in simple bending, with a stress range of substantially zero to a maximum of 137,000 psi. The surface of the specimens was as-rolled on the side subected to tension stress.

One group of 10 fatigue specimens was peened to a very scant coverage as measured on a quantitative basis.

A second group of ten specimens was peened identically to the first group and was then peened under the same conditions with respect to wheel speed and conveyor speed, but with a blast which consisted of broken shot to the same size analysis as that found in the production machine. Since the working shot in the production machine consisted of one part whole shot and five parts broken shot, the fatigue specimens which had been peened with whole shot were then peened with five times as much broken shot.

The results of these tests are shown in Fig. 1, in which the fatigue life of each specimen is shown.

The first group of specimens shown on the extreme left, represents non-peened specimens. The next group to the right represents those specimens peened with whole shot only, and the third group represents those specimens peened with whole and broken shot. Note that the fatigue life is practically unchanged by the addition of the blast with broken shot, despite the fact that the blast of

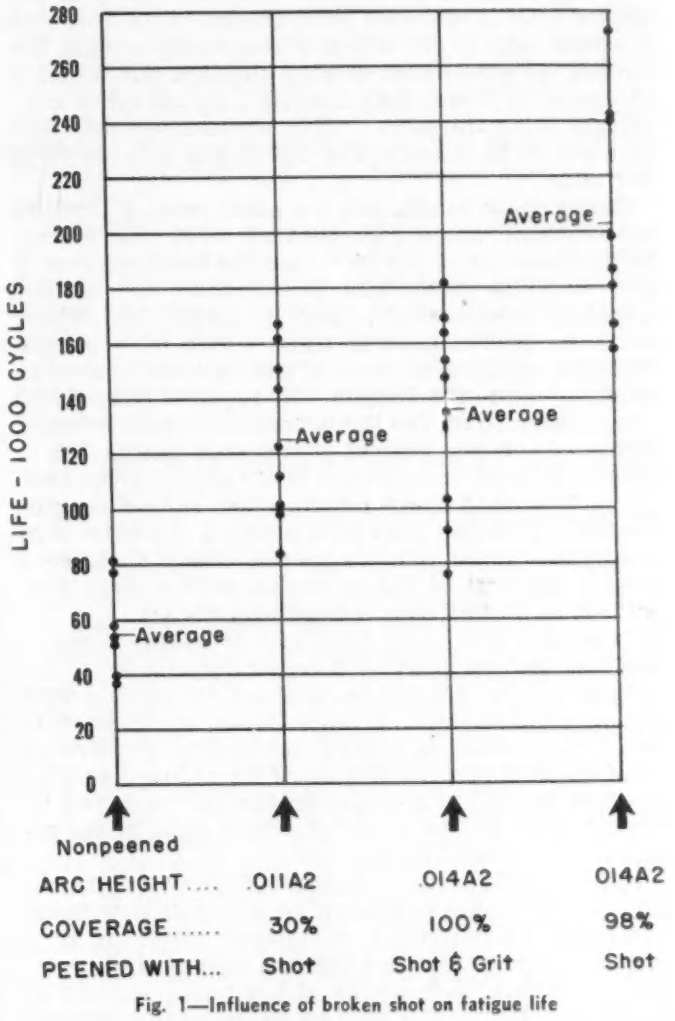



Fig. 1—Influence of broken shot on fatigue life

broken shot had increased the arc height from 0.011 A-2 to 0.014 A-2 and had increased the coverage from only 30% to well over 100%.

This work was done after an extensive series of tests had indicated that under similar conditions, with respect to blast uniformity, the fatigue life increases with increasing arc height up to 0.014 A-2 or greater. It had also been shown, previous to these tests, that under the same conditions with respect to blast uniformity, increased coverage resulted in increased life up to 100%.

Another group of specimens was then peened with whole shot to an arc height of 0.014 A-2 and 98% coverage. Note that the arc height and coverage in the last mentioned group are the same as those obtained with the mixture of whole and broken shot. The results of this group are plotted in Fig. 1, at the extreme right. Note that in this case, the fatigue life is definitely greater than that of the group peened with whole and broken shot, even though the arc height and coverage are the same.

Referring again to groups 2 and 3 in Fig. 1, it is apparent that the broken shot adds nothing to the fatigue life which was obtained with a relatively small quantity of whole shot.

For example, assume that the production peening machine, containing five parts of broken shot and one part whole shot, is operated with a flow rate of 300 lb per min to the wheel. Now assume that the broken shot is removed from the machine and that the flow rate to the wheel is decreased so that the amount of whole shot flowing through the wheel is the same as it was with the mixture, all other conditions being the same. This would mean that flow rate would be one-sixth of 300 lb per min, or 50 lb per min.

Under these conditions, the parts passing through the machine would represent an ideal case for rejection because of the fact that the coverage is only 30% and the arc height is less than 80% of the specified requirements. But in actual fact, those parts are just as good as those which were peened with the mixture, in spite of the vast differences in coverage and arc height. It requires very little imagination to realize the difference in cost between flowing 50 lb per min of whole shot versus 300 lb per min of whole and broken shot through the wheel.

I believe that these results show rather conclusively that broken shot in a peening machine is of utterly no value relative to the whole shot, even though the cost of the operation with a large proportion of broken shot is decidedly higher.

This does not imply that grit or broken shot of itself cannot be used to increase fatigue life. Increased fatigue life can be obtained by blasting with grit or broken shot. It does imply, however, that the broken shot is totally ineffective relative to the full-sized shot by virtue of its reduced weight. In other words, the effect of broken shot is definitely not additive to the effect of whole shot in its relation to increased fatigue life.

Unfortunately, the influence of these factors on fatigue life and cost cannot be recognized without a comprehensive series of fatigue tests. It is a foregone conclusion that the end goal of shot peening is increased fatigue life at low cost. No matter how effective peening may be in increasing fatigue life, it will not be generally accepted unless the cost of the operation is sufficiently low that it will more than pay its own way.

I am more confident now than I ever was that peening can far more than pay its own way, provided the requirements of low cost are recognized. To my knowledge, the largest single factor controlling the ultimate costs of peening is uniformity of the intensity of the blast.

In analysis of what constitutes intensity of the blast, there are three major elements involved:

1—Velocity of the shot. This does not represent a serious problem from a uniformity standpoint. It is unlikely that in a peening operation the shot velocity, in a given blast, would be subject to much more than 10% variation.

2—Hardness of the shot. Uniformity in this case is not a serious problem. If the shot is harder than the work, any variation in shot hardness would have no more than a slight influence, if any, on results; if the elastic limit is not exceeded in peening, it makes little difference how nearly the elastic limit is approached.

3—Size and weight of the individual particle. Uniformity in this case, appears to be the greatest problem of the three. Actually, the present specifications for peening shot allow a variation in size of almost 20%. This does not include the allowance for oversized and undersized shot relative to the nominal size.

For equivalent fatigue life, peening with whole shot of uniform size is unquestionably more economical than peening with shot having a wide range of size. As mentioned, this is not always easy to demonstrate without comprehensive fatigue testing; but in cases where such tests can be made, the result is always the same.

To stabilize a peening machine, (to obtain a high percentage of whole shot in continuous operation), it is necessary to remove the broken shot continuously. If, in replacing the broken shot, the new shot which is added has a wide range of size, then in removing broken shot, the smaller size of the new shot will be removed from the machine without actually having been used in the peening operation.

Approaching the problem from another standpoint, assume that a shot is broken in half. The weight of each broken particle will then be half of that of the original pellet. This half would be equivalent in weight to a whole pellet whose diameter is the cube root of 0.5, or approximately 80% of the diameter of the original pellet. Therefore, it follows that whole shot, whose diameter is less than 80% of that of the large pellets, would be equivalent to broken shot and, would be of no value relative to the larger size.

On this basis, it appears that for peening, the range of shot size should be as close as practical to a range of from 100% to 80%. It is interesting to note that this tolerance is quite close to the present SAE specifications for peening shot.

Since uniformity of shot size appears to be such a vital factor in blast uniformity, I believe that every effort should be made to obtain peening shot with the minimum practicable variation in size.

# Spring Fatigue Life

. . . . . Zimmerli

Continued from p. 36

the highest range that the springs would withstand ten million loadings.

This machine consists of a double throw crankshaft to which, by means of connecting rods, a walking beam is attached. Upright rods to a header transmit the motion to springs mounted on a heavy beam which forms the top of the machine. The whole is driven by a variable speed electric motor. Magnetic relays stop the machine, should a spring break. A counter reduced 100 to 1 automatically records the number of spring compressions while the machine is running. The motor speed range of 1100 to 3300 rpm was carefully tested by means of a a synchronized neon light to be sure no surge or other loading in the machine parts was present to change the calculated stress. For these tests a speed of 2000 rpm was used.

Our results to date are given in Table 1:

The stress ranges given as endurance limits are based on 10,000,000 cycles and have been corrected to allow for the set occurring in the springs during the test.

It will be noted that in one place we could only establish an endurance limit of less than a given figure while in another place we have given it as over a figure. In these instances we had insufficient springs to complete our tests.

The first thing to notice in Table 1 is that in every case the shot peening treatment has increased the endurance limit of the springs. For the lowest figures given we have increased the safe stress range 19.3%. For the highest endurance limit the increase in safe stress range is 56.7%.

It is at once apparent that the P-46 shot is too coarse for these springs. While it has increased the endurance limit over the springs which have not been shot peened, the values in the table are in almost every case lower than for any of the other shot. There would appear to be a tendency to over shot peen with this shot for long times of peening, but the differences are hardly more than the experimental error in our testing.

In the case of the P-28 shot we have a value for our 15 min run which appears low. Actually, for some reason we have not been able to determine, this was caused by the springs setting more than usual during the tests. The stress range is comparable to the other runs with the exception of the springs peened for two hours. The fact that this test is somewhat lower does not necessarily indicate much, because we have a $\pm$ 3000 psi possible machine and setup error. However, it might be well said that the springs are shot peened to the practical limit.

From our data on the various lots of P-16 shot, it does apear that we are obtaining endurance limits with it that are strictly comparable to P-28 shot. It would also indicate that there is practically no difference as far as the endurance limits obtained are concerned whether, within the limits of the hardness used, we use hard or soft shot.

If we refer to the arc heights (which we obtained during the various shot peening operations) and compare them with the endurance limits determined for the springs which were peened with the Almen strips, it is readily apparent that in an investigation of this type there is absolutely no correlation between arc height and endurance limit.

From our data there does not appear to be any tendency to over shot peen using the P-16 shot.

The depth of cold working with different size shot has not been completely worked out. If the larger shot does go deeper, then standards of shot size for various wire sizes should be considered. Also, peening hot wound springs with some ferrite the heavier shot then might be an advantage. It is hoped that this data by X-ray (or any other method) can be soon made available to all interested parties.

We know that the softer shot gives us lower maintenance of our equipment. Our tests here in 1939 and 1940, and reported to A.S.M. in 1941, showed equal fatigue life. These tests confirm the previous runs in that soft shot from an endurance point of view will produce results comparable with the hard shot. It is evident that an economy can be achieved using steel or a heat-treated cast-iron shot.

At present this will be hard to accomplish because (1) inspection departments and some metallurgists use visual means to say whether or not a part is properly shot peened, and (2) government and some company prints often carry an arc height as part of the peening outline. This will have no beneficial effect on the quality that will be received by these agencies but may well determine the kind of shot to be used.

Actually, such a specification could lower the quality of the peening. By adding a little oversize shot to the machine it is possible to raise the arc height quickly, but not the spring endurance limit which might go less than that anticipated.

After 60 days continuous running using soft shots on valve springs, we have some production figures which indicate to us:

(a) One lb of steel shot will equal 6 lb of white cast-iron shot.
(b) The steel shot cuts repairs to equipment by 50% minimum.
(c) Steel shot will not remove small burrs or similar grinding imperfections from springs. Springs appear bright and unpeened.
(d) So-called malleablized white cast iron carries enough white iron shot that breaks into grit to remove burrs in the samples tested.
(e) Routine fatigue tests on test springs run with valve springs over this period of time averaged slightly higher stress range with steel than when white cast iron shot was used on production work. Such springs were peened with P-28 shot 30 min with a 115-lb charge of automotive valve springs in the machine. This is average production data and should not be confused with the smaller number of springs in the machine when the experimental tests were run. It is simply given to show a trend.

# AIR BRAKES—

EXCERPTS FROM PAPER* BY

**Stephen Johnson, Jr.**

Chief Engineer
Bendix-Westinghouse Automotive Air Brake Co.

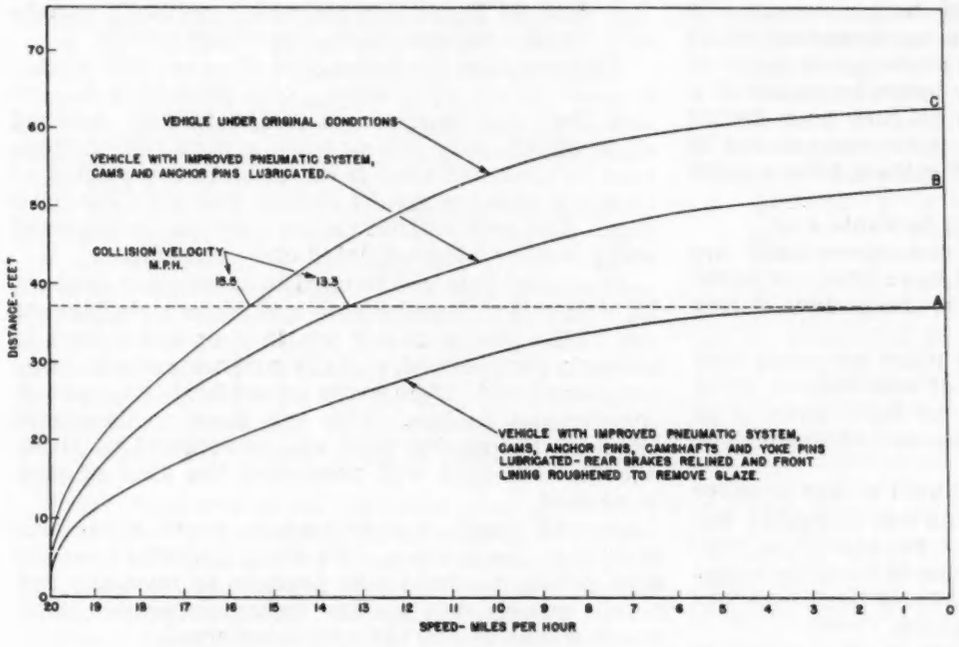

VEHICLE UNDER ORIGINAL CONDITIONS
VEHICLE WITH IMPROVED PNEUMATIC SYSTEM, CAMS AND ANCHOR PINS LUBRICATED.
COLLISION VELOCITY M.P.H.
15.5
13.3
VEHICLE WITH IMPROVED PNEUMATIC SYSTEM, CAMS, ANCHOR PINS, CAMSHAFTS AND YOKE PINS LUBRICATED- REAR BRAKES RELINED AND FRONT LINING ROUGHENED TO REMOVE GLAZE.
A
B
C
DISTANCE-FEET
SPEED- MILES PER HOUR

Fig. 1—Brake performance before and after brake analysis (vehicle traveling at 20 mph)

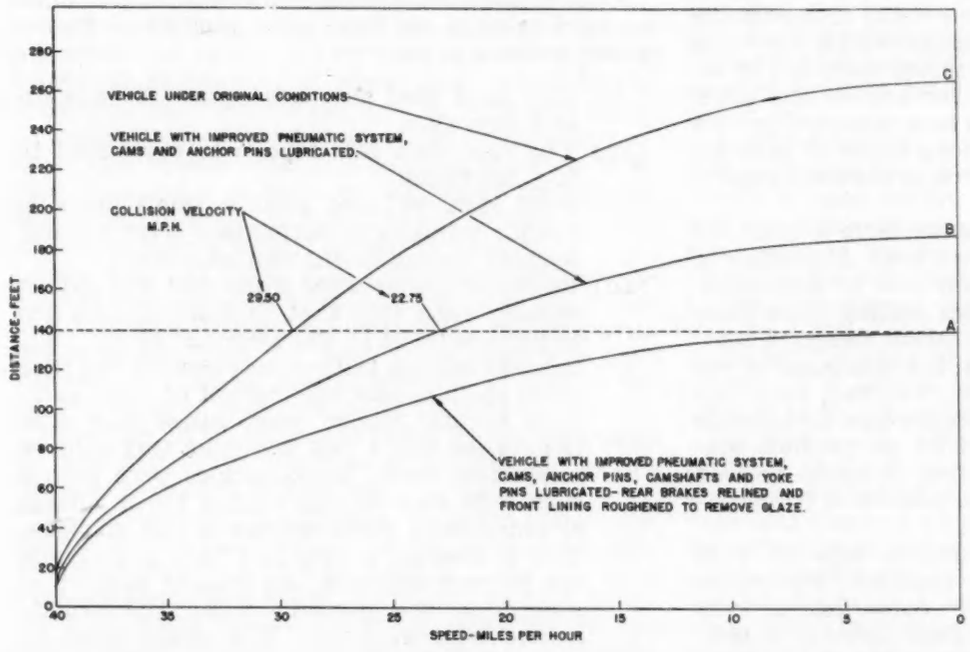

VEHICLE UNDER ORIGINAL CONDITIONS
VEHICLE WITH IMPROVED PNEUMATIC SYSTEM, CAMS AND ANCHOR PINS LUBRICATED.
COLLISION VELOCITY M.P.H.
29.50
22.75
VEHICLE WITH IMPROVED PNEUMATIC SYSTEM, CAMS, ANCHOR PINS, CAMSHAFTS AND YOKE PINS LUBRICATED- REAR BRAKES RELINED AND FRONT LINING ROUGHENED TO REMOVE GLAZE.
A
B
C
DISTANCE-FEET
SPEED-MILES PER HOUR

Fig. 2—Brake performance before and after brake analysis (vehicle traveling at 40 mph)

# — Design and Performance

(This paper will be printed in full in SAE Quarterly Transactions)

IT is not the purpose of this paper to deal with the detail construction or operation of air brake apparatus, but rather to cover the subject in a more general way.

Considering the subject of braking as an art capable of being reduced to a more or less exact science, we find that it is a big proposition—certainly too broad to be treated in a paper of this kind. But it can be said that the air brake ranks high among those forces to which the material developments of highway motor transport of the present day are primarily due.

The problems of deceleration, retardation, and the flexible control of automotive vehicles must and will receive more and more attention from the scientific and technical standpoint in order that theory and practice be combined to produce the best results. This is necessary if the brake is to meet satisfactorily the conditions that have developed in automotive transportation. The relatively high speeds and vehicle weights of the present day require that advantage be taken of every opportunity offered to increase and flexibly control braking power.

Starting and stopping of automotive highway vehicles are complementary factors in the problem of meeting transportation schedules, so it is evident that best results can only be obtained where both factors are given due consideration. Generally, the starting factor is the only one fully considered or, at least, the one more fully provided for, notwithstanding the fact that better results can be obtained if both are considered and an efficient brake system installed.

Unfortunately, the brake is usually looked upon as a safety device only. We believe it is because of the prevalence of this idea that its installation and maintenance do not receive the consideration they merit. Considering the investment, there is no part of the vehicle that will give greater material returns than the brake when properly installed, operated, and maintained. If the brake system could, to some extent, be separated from the idea or impression that it is a safety device only and proof advanced to show that without the aid of it, heavy-duty transportation of passengers and freight as we know it today, would be impossible, that it makes possible faster and more frequent service—as much or more than does the engine power of the vehicle itself, or the highway itself, and that if given the consideration it should have, it would increase the possibilities, profits, and value of all these things—then we believe, its importance would be more fully appreciated and, therefore, at least the same consideration be given to its design and installation that is accorded to other components of the vehicle. As a safety device the air brake is par excellence; but it has other reasons for its existence. No more useless expenditure can be made than for brakes that are not properly maintained; for they, then, not only fail to perform as expected or desired, but not infrequently become a hindrance rather than a help to the movement of motor transport trains when these wrong conditions are allowed to develop and continue. Brake failures are largely the direct result of either poor maintenance or improper manipulation on the part of the operator.

### Adequate Maintenance

It is becoming more evident to all those interested in this matter of brakes that a high brake efficiency is of great value, but if it is to be secured and preserved, it is essential that adequate brake departments should be established and maintained, competent both to care for the brake apparatus and to instruct men as to its proper use.

It is hoped that those in authority will realize that the question of training and proper provision for brake maintenance and inspection is a continuing one.

In my opinion, most of the chronic braking

* Paper, "Air Brakes—Design and Performance—Past, Present, Future," was presented at the SAE National West Coast Meeting, San Francisco, Aug. 18, 1948.

troubles being experienced today on heavy-duty vehicles could be eliminated if the brakes were analyzed and then subjected to a well-planned and executed periodic maintenance program.

The rewards for those who will analyze the brakes on their vehicles are great and can be best illustrated by the curves shown in Figs. 1 and 2.

Figs. 1 and 2 show the braking performance of the vehicle before and after brake analysis and corrective maintenance measures.

In the case of the vehicle traveling at 20 mph (Fig. 1) with brakes in condition C and the driver sighting an object in the road 37 ft away and applying his brakes instantly, the vehicle would strike the object with a collision velocity of 15.5 mph. With brakes in condition B it would strike the object with a collision velocity of 13.3 mph. With brakes in condition A it would stop before striking the object.

In the case of the vehicle traveling at 40 mph (Fig. 2) the value of proper analysis and corrective measures is more significant because if the vehicle has brakes in condition C and the driver sights an object in the road 140 ft away and applies his brakes instantly, the vehicle would strike the object with a collision velocity of 29.5 mph. With brakes in condition B it would strike the object with a collision velocity of 22.75 mph. With brakes in condition A it would stop before striking the object.

Certainly this proves beyond question the value of brake analysis and maintenance on the part of the operators of the vehicle.

Figs. 3 to 7 represent the evolution of air brake performance over a period of approximately 25 years.

This word "lag" or phrase "lag in the brake system" is used too loosely by too many and I want to be emphatic in stating that lag is the time elapsing or

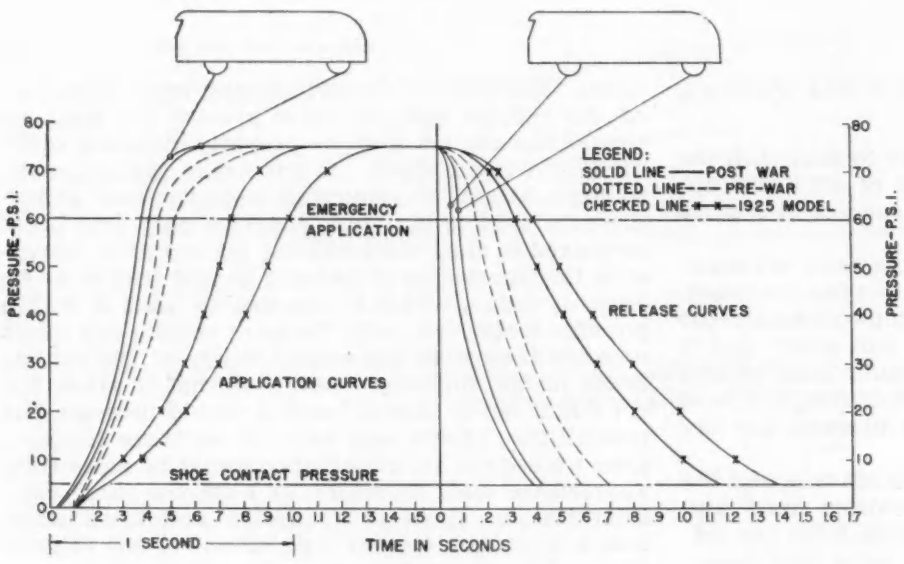



Fig. 3—Air transmission times for 35-41-passenger buses—prewar and postwar equipment

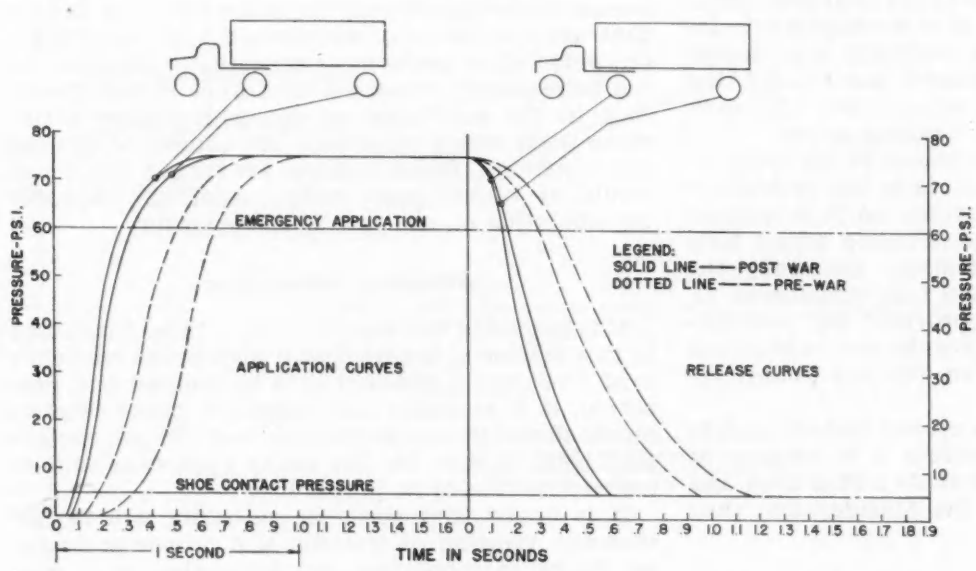



Fig. 4—Air transmission times for 4-wheel tractor and single-axle semitrailer—prewar and postwar equipment

distance traveled between the instant or point at which the driver contacts the braking controls and the instant or point at which the brake shoes touch the brake drums.

As far as vehicles equipped with air brakes are concerned, on the average it takes about 5 psi pressure in the brake chambers to place the shoe against the drum, so that after this pressure has been reached, from there on to any pressure above 5 psi, work is actually being done. In other words, the time element in building up from 5 psi to 60 psi pressure, for instance, is very definitely not lag but a period of time in which work or braking is done.

New or improved air brake apparatus that has been recently released or is now in the process of being released for production, includes a line of 2-cyl 12 cu ft displacement compressors known as the type E, which supersedes the old 3-cyl compressor having the same displacement, a large-capacity brake valve known as type D-1, rotochambers, which function the same as and supplement the line of brake chambers, positive-lock-type slack adjusters, and large-capacity relay emergency valves for trailers with provision for installing one directly on the reservoir, simplifying the installation.

### Future Air Brake Apparatus

Future air brake apparatus now under engineering development, most of which is ready for field service trial, includes new and improved low-pressure indicators, stoplight switches, compressor governor, an arrangement of various air brake devices mounted integrally on a reservoir, which offers interesting possibilities in the matter of simplifying the installation on a vehicle, a positive-lock type of hose coupling, a new, combined quick release and limiting valve, which will limit the front brakes to

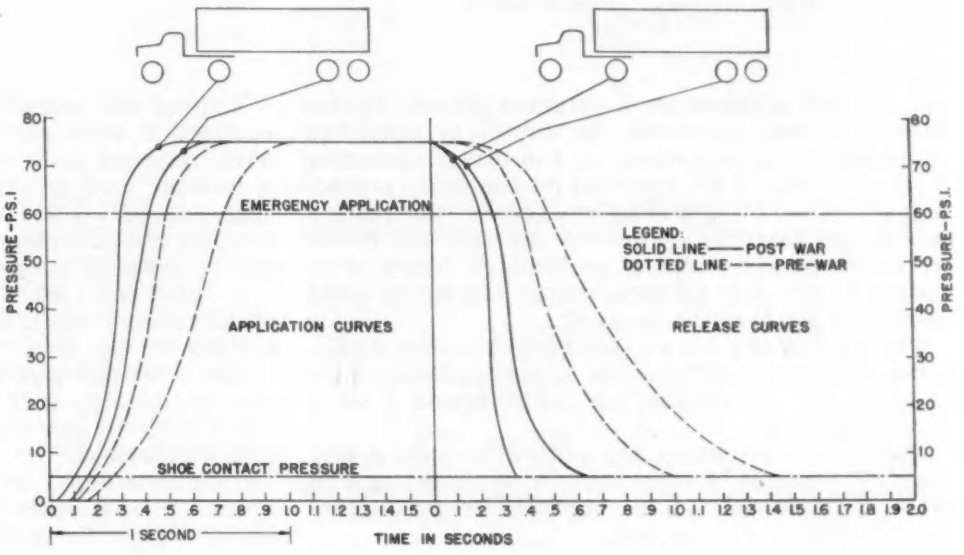



Fig. 5—Air transmission times for 4-wheel tractor-tandem-axle semi-trailer—prewar and postwar equipment

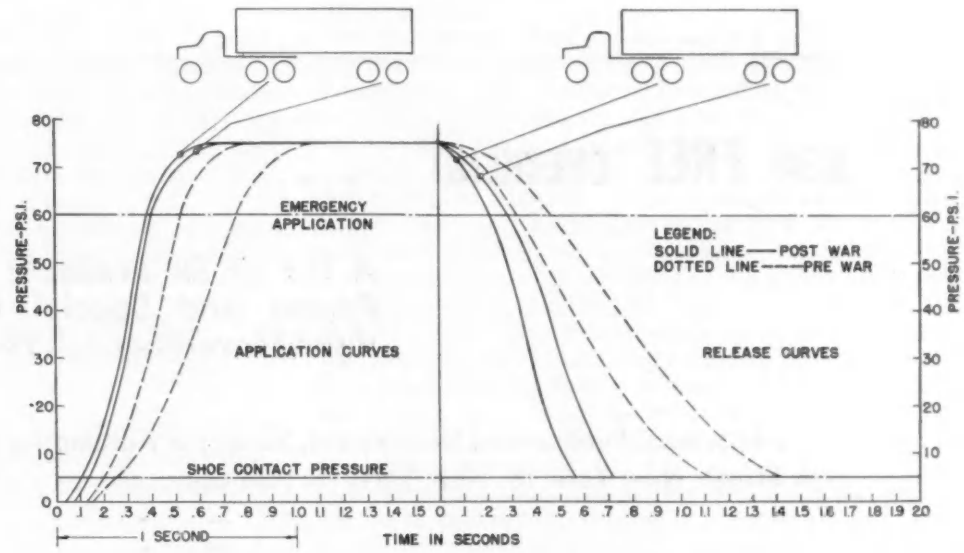



Fig. 6—Air transmission times for 6-wheel tractor-tandem-axle semi-trailer—prewar and postwar equipment

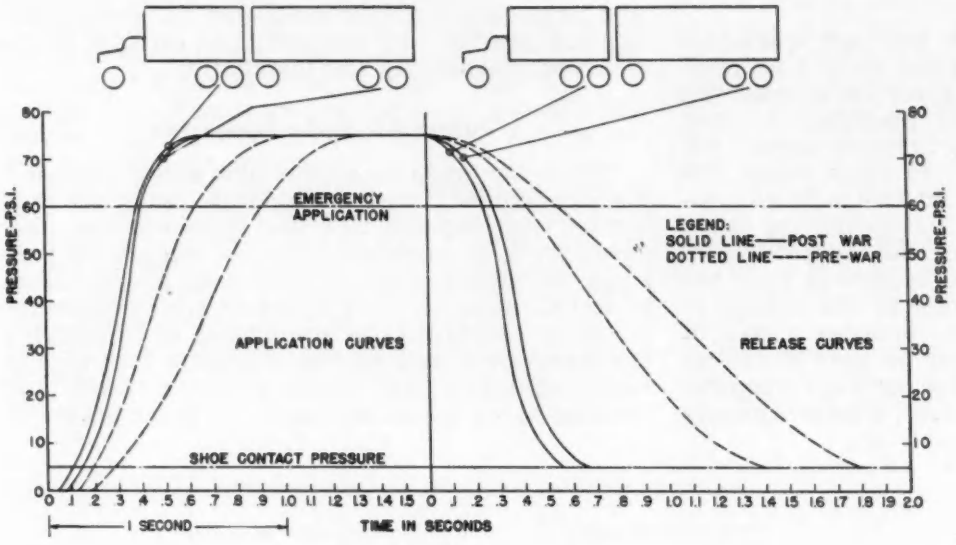



**Fig. 7—Transmission times for 6-wheel truck—6-wheel full trailer**
**Truck equipped with type D-1 brake valve, R-1 relay valve; trailer front equipped with R-1 relay valve, trailer rear equipped with RE-1 relay emergency valve—prewar and postwar equipment**

50% of what air pressure is obtained for rear brakes with proportional control, the limited or unlimited condition being controlled by the driver operating a simple 2-way valve mounted on the dash, protection valves, and a new relay emergency valve with a superlarge capacity, intended for use on motor transport vehicle trains of particularly heavy gross vehicle weight and extreme length and where great volume of air must be handled.

There are many things that come to us for evaluation and tests, and history and experience show them to be not suitable for manufacturing on a production basis.

New ideas—invention and otherwise—take a tremendous amount of man-hours in engineering and most of them fail to be suitable for production manufacturing and service.

Engineering research and development work in connection with air brakes that has been vigorously renewed since the end of World War II is of a broader and greater magnitude than anything that has been done in the past and in the final analysis will undoubtedly result in greatly enhancing the progress of automotive transportation.

In conclusion, let me say that we are entering an era of better brakes. As someone said, it is not how quickly we can stop a vehicle—not in how short a distance we can stop a vehicle—but how short can the vehicle stop without the vehicle being turned into a sled—in how short a distance can the vehicle stop with safety.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

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# SELECTION of TRANSIT EQUIPMENT

BASED ON PAPER* BY

**Charles Guernsey**

Vice-President and General Manager
Transit Equipment Division
Marmon-Herrington Co., Inc.

EXPERIENCE in building all types of transit equipment and observation of operations under all sorts of conditions leads to the conclusion that, in its field, the trolley coach is faster, cleaner, quieter, smoother, more attractive to the public, more reliable and—properly applied—lower in cost of operation than any other type of transit equipment developed to date.

Both the street car and the motor bus have their proper place. The motor bus is best adapted where lines have comparatively long headway, where the community is unsettled, where long express routes of a more or less suburban nature are to be handled, or where the service is of a transitory nature. They also have the advantage that they can be readily shifted from one line to another.

### Large Buses on Test

Recent developments in rubber-tired equipment have considerably narrowed the field for the surface lines rail car. Trolley coaches now so closely approach the capacity of the trolley car that they can be substituted almost on a one-for-one basis. Large capacity motor buses are also in test.

Purchase and installation of additional rail cars would seem to be justified only where some unusual circumstance prevails, such as:

- Existence of rail in excellent condition, and reluctance of the operating company to write off that investment;
- Some unusual operating conditions, such as partial operation in a subway or other private right of way, or possible multiple unit operation, and
- Unusual franchise conditions which grant the operating company better conditions for rail operation.

We believe new street car installations will be limited to such applications, even granting that the modern street car has done a very creditable job.

A check of 1946 operations of 22 companies, of which 15 had rail operations and 14 had trolley coach operations, showed an operating ratio for the trolley coaches of 59.74, whereas the trolley cars has an operating ratio of 72.37, although the passenger revenue per vehicle mile for the rail vehicles was 54.40c, as compared to 48.30c for the trolley coach.

It will be obvious that the cars were operating on the heavier and, therefore, more desirable lines on which it seems trolley coaches would have shown higher profits.

In considering the continued use of cars, let us face this fact: street congestion is getting worse by the minute. Car tracks on the center of the street, with their safety islands, are a serious block to general traffic flow, and in many cities the traffic authorities and the general public are bringing pressure to get rid of them. This is particularly troublesome where a combination of narrow streets and parking complicates the situation.

It appears that for all cities under perhaps 500,000 population, and for the vast majority of lines even in the largest cities, rubber-tired transportation will give the best solution. Many factors must be taken into account in choosing between the various sizes and types of motor buses and modern trolley coaches. The increasing cost of equipment, but even more important, the high cost of maintenance and operating labor, have changed the relative advantages materially in the last three years.

The obvious objective in a transit operation is to give the best service at the lowest cost. This does

* Paper "Selection of Transit Equipment" was presented at SAE Indiana Section, March 11, 1948.

not mean that the cheapest per mile operation will necessarily be the most profitable. Before an operation can be profitable, regardless of the operating cost, the service must be such that public satisfaction results. It is poor economy to run unattractive equipment.

Service must be satisfactory to the riders, property owners, merchants, manufacturing plants and business establishments of all sorts. They must all be adequately served. Other users of the streets must also be considered. Vehicles selected for any given route should be the largest usable, consistent with reasonable maneuverability and headway. In general, large vehicles should be applied on the heaviest and longest lines. This lowers cost of operation and reduces traffic congestion by limiting the number of vehicles required to handle a given load.

Trolley coaches are satisfactorily suited to this sort of operation for many reasons:

- They appeal to the riding public because they are smooth and silent in operation, completely free from vibration, have no odors, are well lighted, heated and ventilated, can accelerate and operate at a higher schedule speed, and they load at the curb.

- Property owners like them because there is evidence of a permanent, fixed route, they are quiet and free of odors, and give dependable service.

- They operate at lower expense because maintenance cost is low. Simple electric motor, dynamic braking and fewer wearing parts are advantageous. Electric power cost is inexpensive and the cost trend is downward. Lower transportation expense can be achieved because of higher schedule speed. The higher availability and higher schedule speed reduce the number of vehicles required.

- Depreciation expense is lowered because of their longer useful life. Trolley coaches can be depreciated on the basis of 12 to 15 years life, as against 8 to 10 years for motor buses. Minimum shop facilities are required. They can be stored out of doors, reducing shop and garage investments. A lesser number of vehicles are needed because of their greater availability, greater rush hour capacity. In general, trolley coaches have wider aisles and more doors, and larger front platform, all facilitating movement. Fewer unscheduled vehicles are required.

The trolley coach has a further advantage in cold climates because it is not so much affected by weather conditions as are buses. Where heavy or long grades are encountered, the trolley coach is indicated, even on light lines.

## Claims Superiority

For the heavier, well established lines we consider the trolley coach to be superior in every respect to the motor bus. This is borne out by the increasing number of trolley coaches being purchased by an increasing number of operators, and by the general satisfaction with their operations. The average results of 28 companies operating trolley coaches during 1946, as reported to the American Transit Association, shows the operating ratio on this particular group of properties was 58.0.

It should be said in all fairness when making a

**Table 1**

Operating Cost Per Mile, Cents

| | 44 Pass. Motor Bus | 44 Pass.* Trolley Coach | 48 Pass.* Trolley Coach |
|---|---|---|---|
| Maintenance | | | |
| Way and Structures | | 1.13 | 1.13 |
| Vehicles and Tires | 7.89 † | 4.23 | 4.23 |
| Operating Costs | | | |
| Power or Fuel | 5.50 | 3.80 | 3.80 |
| Conducting Trans. | 14.78 | 14.78 | 14.78 |
| General & Misc. | 5.10 | 5.10 | 5.10 |
| Traffic | .17 | .17 | .17 |
| (1) Depreciation of vehicles | 5.48 | 3.65 | 3.81 |
| Total expense per mile | 38.92¢ | 32.86¢ | 33.02¢ |

† Average of 6 Companies using buses averaging 41 seats.
* Average as reported by 28 properties in 1946.
(1) Buses over 8 years. Trolley Coaches 12 years. 40,000 miles per year.

**Table 2**

Operating Data
12 Mile Round Trip Line
2000 Passengers Per Peak Hour

| | 44 Pass. Motor Bus | 44 Pass. Trolley Coach | 48 Pass. Trolley Coach |
|---|---|---|---|
| Price each | $ 17,500 | $ 17,500 | $ 18,300 |
| Total capacity for scheduling purposes | 66 | 72 | 80 |
| Schedule speed | 10.5 | 11.5 | 11.5 |
| Assumed load per hour (peak) | 2000 | 2000 | 2000 |
| Number vehicles per hour at peak point | 30.4 | 27.8 | 25 |
| Vehicles on line | 35 | 29 | 26 |
| Spares—15% | 5 | | |
| Spares—3% | | 1 | 1 |
| Total vehicles | 40 | 30 | 27 |
| Total cost vehicles | $700,000 | $525,000 | $494,000 |
| Peak hours—2 hours per day. Peak miles operated | 840 | 720 | 598 |
| Peak headway | 1.97 Min. | 2.16 Min. | 2.4 Min. |
| Off peak headway based on seated load | 6.25 Min. | 6.3 Min. | 7 Min. |
| Number vehicles on line | 11 | 10 | 9 |
| Off peak daily miles | 2300 | 2300 | 2070 |
| Total daily miles | 3140 | 3020 | 2668 |
| Annual miles | 1,150,000 | 1,110,000 | 970,000 |

**Table 3**

Annual Operating Costs
12 Mile Round Trip Line
2000 Passengers Per Peak Hour

| | 44 Pass. Motor Bus | 44 Pass. Trolley Coach | 48 Pass. Trolley Coach |
|---|---|---|---|
| Cost per mile including depreciation of vehicles | 38.92¢ | 32.86¢ | 33.02¢ |
| Miles operated | 1,150,000 | 1,110,000 | 970,000 |
| Total Cost of Operation | $ 448,000 | $ 363,000 | $320,000 |
| Depreciation of Storage and Shops at 2% | $ 6,400 | $ 2,100 | $ 1,960 |
| Interest on Investment ½ value @ 3% | $ 4,800 | $ 1,570 | $ 1,470 |
| Depreciation of Line @ 5% | | $ 9,000 | $ 9,000 |
| Interest on Line 3% ½ value | | $ 2,700 | $ 2,700 |
| | $ 459,200 | $ 378,370 | $334,130 |
| Saving per year over 44-Passenger Motor Bus | | $ 80,820 | $125,070 |

**Table 4**

Operating Data
12 Mil. Round Trip Line
600 Passengers Per Peak Hour

| | 44 Pass. Motor Bus | 44 Pass. Trolley Coach | 48 Pass. Trolley Coach |
|---|---|---|---|
| Price each | $ 17,500 | $ 17,500 | $ 18,300 |
| Capacity for scheduling | 66 | 72 | 80 |
| Schedule speed | 10.5 | 11.5 | 11.5 |
| Assumed load peak hour | 600 | 600 | 600 |
| Number vehicles per hour at peak | 9.1 | 8.35 | 7.5 |
| Vehicles on line | 10 | 9 | 8 |
| Spares—15% | 2 | | |
| Spares— 3% | | 1 | 1 |
| Total vehicles | 12 | 10 | 9 |
| Total cost vehicles | $210,000 | $175,000 | $165,000 |
| Peak-2 hours daily miles operated | 126 | 115 | 104 |
| Peak headway | 5.72 | 6.25 | 6.95 |
| Off peak headway not to exceed 10 min. | 9.4 | 8.9 | 8.9 |
| Vehicles on line off peak | 7 | 7 | 7 |
| Off peak miles 20 hours daily | 1470 | 1610 | 1610 |
| Total daily miles | 1596 | 1725 | 1714 |
| Annual miles | 583,000 | 630,000 | 625,000 |

comparison with motor buses, that the trolley coaches are ordinarily operated on the heavier and, therefore, the more profitable lines. The group of properties had revenue per mile of 48.30c for the trolley coach against 32.70c for the motor bus.

Installing overhead lines does not necessarily make the first cost on trolley coach applications higher than for motor buses. In general, it is not true on heavy lines. Where completely new facilities are required, both for the trolley coach and the motor bus, the cost for the trolley coach, its necessary shops, storage facilities (out of doors), overhead line feeders, and so forth, must be balanced against the cost of buses with their related shop and garage facilities.

## Heated Garages a Problem

General experience indicates that in most of the United States satisfactory operation of motor buses requires heated garages. For trolley coaches, less than 3% of spares are required on the average, while for motor buses approximately 15% of spares are required. Further, by reason of their larger capacity resulting from higher schedule speed, and wider aisles, fewer trolley coaches are required to perform a given schedule.

It is quite probable, therefore, that a lower original investment will be required under conditions where peak headways are less than four to six minutes.

Maintenance cost of an average of six companies using large capacity motor buses, as reported to ATA in 1946, are shown in Table 1.

It is assumed that fuel consumption would be three miles per gallon costing 16½c per gallon with tax paid. Depreciation is based on present day costs. Other items, such as conducting transportation, general and miscellaneous, are assumed to be the same as the trolley coach. Table 2 shows the number of vehicles required, total cost of vehicles, headways, and miles operated, on the assumption that there would be a peak demand of 2,000 passengers per hr for a period of two hrs a day, and that the off peak load would be approximately 1/3 of the peak load, total operation 22 hr per day.

Table 3 shows the predicted annual operating cost on this hypothetical line. It will be noted that 48-passenger trolley coaches would make an annual saving, as compared to the motor bus, of $125,000, or a saving over a 15 year life of $1,875,000. The 44 passenger trolley coach shows a saving of about $81,000 per year, or a saving over 15 years of about $1,200,000.

If we assume the same line to have a peak load of only 600 passengers per hour, and that the maximum headway in off peak should not exceed ten minutes, then the operating conditions are as outlined in Table 4. Table 5 shows the annual savings under this condition. It will be seen that the operating costs of the bus and the trolley coach are more nearly equivalent.

It seems probable that if the load had been reduced to 400 passengers per hour, the motor bus would have shown the greatest economy. Table 6 shows the approximate investment cost for two different traffic densities. These figures are based on the assumption that the line is completely new, and no shops, garages, barns, overhead equipment, or other facilities exist.

**Table 5**

Annual Operating Cost
12 Mile Round Trip Line
600 Passengers Per Peak Hour

| | 44 Pass. Motor Bus | 44 Pass. Trolley Coach | 48 Pass. Trolley Coach |
|---|---|---|---|
| Cost per mile including depreciation of vehicles | 38.92¢ | 32.86¢ | 33.02¢ |
| Miles operated | 583,000 | 630,000 | 625,000 |
| Total cost operation | $226,500 | $206,000 | $206,500 |
| Depreciation Storage & Shop @ 2% | $ 1,920 | $ 700 | $ 630 |
| 3% on ½ value | 1,440 | 525 | 473 |
| Interest on Investment, Depreciation on line @ 5% | | 9,000 | 9,000 |
| Interest on line 3% on ½ value | | 2,700 | 2,500 |
| | $229,860 | $218,925 | $219,103 |
| Annual savings in operating cost over 44-Passenger Motor Bus | | $ 10,935 | $ 10,757 |

**Table 6**

Cost of Facilities
12 Mile Line
2000 Passengers Pack Hour

| | 44 Pass. Motor Bus | 44 Pass. Trolley Coach | 48 Pass. Trolley Coach |
|---|---|---|---|
| Vehicles | $ 700,000 | $525,000 | $494,000 |
| Storage & Shop facilities per vehicle | $ 8,000 | $ 3,500 | $ 3,500 |
| Total | $ 320,000 | $105,000 | $ 98,000 |
| Line Cost @ $30,000 Total Capital Investment | $1,020,000 | $810,000 | $772,000 |

Cost—Same Line
600 Passengers Per Hour

| | | | |
|---|---|---|---|
| Storage & Shop facilities per vehicle | $ 8,000 | $ 3,500 | $ 3,500 |
| Total | $ 96,000 | $ 35,000 | $ 31,500 |
| Cost of vehicles | $ 210,000 | $175,000 | $165,000 |
| Cost of line | | $180,000 | $180,000 |
| Total Capital Investment | $ 306,000 | $390,000 | $376,500 |

Overhead line material on a typical line can be installed for $25,000 per mile. We have used a figure of $30,000 per mile. It is assumed that for the motor bus heated storage facilities, as well as shops and shop equipment, will be required. On the basis of 800 sq ft per bus, which covers storage, inspection pits, shop, wash rack, store rooms, and so forth, the cost of facilities would be $8000 per vehicle.

Trolley coaches will require enclosed heated facilities for inspection, wash rack and shop, but storage will be out of doors, in which case the cost per vehicle is $3500.

Because each problem is distinct, the proper decision in any one case must be based on facts.

In many cases selection of new equipment has been made without a full consideration of all of the possibilities of each type and size of vehicle available to operators of the growing transit business in this country.

Actual first cost invested for the trolley coach on the heavy density line is some $248,000 less than for the bus.

When considering the lighter line, however, there is a saving in first cost in favor of the motor bus of some $70,000 when compared with the 48 passenger trolley coach.

Lighter lines with longer headways make the cost of installing overhead lines a more important item, and the motor bus will show the greatest economy in first cost, and in the *very light* services, in cost of operation as well. Fuel and power cost, maintenance cost, density of line, size of vehicle required, nature of territory to be served, and other variables will shift the actual point where advantages of the one may exceed the other.

## Territory is Factor

In general, the trolley coach should be kept in the well-developed, settled territories, with the motor bus used in new suburbs and sub-divisions which have not yet crystallized. The motor bus should also be used where the line is subject to future change. In many cities, suburbs have developed in such a way that they can best be served by express buses supplementing the normal transit type of service.

A recent study showed that on a given line the use of 23 48-passenger trolley coaches, as compared with 25 44-passenger trolley coaches, will result in a saving throughout the life of the vehicles of more than $300,000 at present day costs. The most careful analysis must be made to assure the best overall results.

Where existing facilities can be converted to the advantage of either the trolley coach or motor bus, a corresponding change in the initial cost relationship will result. But the operating advantage of the former will usually justify its selection for the heavier service as indicated.

Regardless of the type of equipment properly selected for any given line, make it and keep it modern. This insures more public satisfaction and greater income per mile, and in most cases actually reduces operating cost. In many cases the depreciation of the new vehicle is much less than the difference in maintenance of an old one.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25c to members, 50c to nonmembers.)

BASED ON PAPER* BY

**L. C. Wolcott**

Chief Engineer,
Packard Electric Division, GMC

# *How To Do A Better Job*

# WIRING TRUCKS and BUSES

(This paper will be printed in full in SAE Quarterly Transactions)

TRUCK and bus wiring systems will deliver best service if patterned after this simple three-point formula:

1. Conductors capable of carrying the current load.
2. Insulation of sufficient electrical and mechanical strength to withstand environment and abuses of the installation.
3. Terminals and connectors securely installed.

To find the proper wire gage size for the various vehicle electrical circuits, both amount of current to be carried and length of wire in the circuit must be considered. On low voltage systems the voltage drop between the battery and point of use is an important factor.

Table 1 is a useful guide for selection of proper wire gage size. When both current load and length of wire in the circuit are known, the wire gage can be read from the chart.

Generally the allowable voltage drop in a circuit is ½v for 6-v systems and 1v for 12-v systems. Exceptions are generator-to-battery and solenoid control circuits. Here the voltage drop should not exceed ½v on 12-v systems. To keep the wire from overheating, do not use a wire smaller than the one where a circuit length is indicated in the table.

Cable for starting motor circuits must be of such gage size that it will carry the current load for the starter motor, deliver that current with a high enough voltage at the motor for its proper functioning.

A safe rule is to use cable of such size that the total calculated resistance in all leads in the starting motor circuit (including battery ground cable or strap) does not exceed: (1) 0.001 ohm for 6 and 12-v systems and (2) 0.002 ohm for 24 and 32-v systems.

Instead of calculating voltage drop, some engineers adopt as standard certain gage sizes for certain types of installations. For examples, one manufacturer regularly uses 00 gage for his 6 and 12-v gasoline-powered trucks and 000 gage for his coaches and all diesel-powered jobs. On any new motor installation, the job should be checked under cold

*Paper "Factors Affecting the Design and Installation of Wiring Systems for Commercial Vehicles," was presented at SAE Summer Meeting, French Lick, June 7, 1948.

Table 1—Chart For Determining Proper Gage Size of Copper Wire

| A.W.G. WIRE SIZE | 16 | | 14 | | 12 | | 10 | | 8 | | 6 | | 4 | | 2 | | 0 | | 00 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VOLTS DROP @ 68F. | ½ | 1 | ½ | 1 | ½ | 1 | ½ | 1 | ½ | 1 | ½ | 1 | ½ | 1 | ½ | 1 | ½ | 1 | ½ | 1 |
| AMPERES | TOTAL LENGTH OF WIRE IN CIRCUIT (FT) | | | | | | | | | | | | | | | | | | | |
| 5 | 25 | 50 | 40 | 79 | 63 | 126 | 100 | | | | | | | | | | | | | |
| 10 | 13 | 25 | 20 | 40 | 32 | 63 | 50 | 100 | 80 | 160 | 127 | | | | | | | | | |
| 20 | | | 10 | 20 | 16 | 32 | 25 | 50 | 40 | 80 | 63 | 127 | 100 | | | | | | | |
| 30 | | | | | | | 17 | 33 | 26 | 53 | 42 | 84 | 67 | 134 | 107 | | | | | |
| 40 | | | | | | | | | 20 | 40 | 32 | 63 | 50 | 100 | 80 | 160 | 127 | | | |
| 50 | | | | | | | | | | | 25 | 50 | 40 | 80 | 64 | 128 | 102 | 203 | 128 | |
| 60 | | | | | | | | | | | | | 34 | 67 | 53 | 107 | 85 | 170 | 107 | |
| 70 | | | | | | | | | | | | | 29 | 58 | 46 | 91 | 73 | 145 | 92 | 184 |
| 80 | | | | | | | | | | | | | | | 40 | 80 | 64 | 127 | 80 | 161 |
| 120 | | | | | | | | | | | | | | | 27 | 53 | 42 | 85 | 53 | 107 |
| 140 | | | | | | | | | | | | | | | | | 36 | 73 | 46 | 92 |
| 160 | | | | | | | | | | | | | | | | | 32 | 64 | 40 | 80 |

conditions to be sure voltage drop and battery size are such that it will start under the most adverse conditions anticipated.

After selecting the right gage size, decision must be made as to the kind of conductor and insulation the job demands. Aim here is to find the most economical type that will hold up under the type of service to which the wiring system will be subjected. Let's look into these considerations for ignition wiring, starting motor circuits, and power and lighting circuits.

### High Voltage Wire

For the ignition system we are concerned only with the high voltage wires from the ignition coil to the distributor and from the distributor to each spark plug. Construction of the three kinds of wiring used in this service is illustrated in Fig. 1.

First type, shown at the top, consists of a copper conductor, a rubber insulation of high dielectric strength, and a cotton braid covering, finished with a heavy coating of special heat-resistant lacquer. The braid and its lacquer covering are designed to protect the rubber from harmful effects of oil and gasoline. By excluding most of the air from the rubber surface, this also protects the insulation from electrical corona cracking.

But this is far from adequate protection, no longer considered satisfactory for use under severe conditions. The lacquer coating may get scraped or broken in handling; it eventually breaks because of embrittlement with age. This allows the braid to absorb any oil present, swelling the rubber compound and bursting the braid. Moisture also can saturate the braid, which produces annoying flashover from terminals to ground.

Second cable type shown in Fig. 1 is similar to the first as regards conductor and insulation. But protection for the insulation consists of a sheath or jacket of neoprene compound. This neoprene sheath excludes all air from the surface of the rubber insulation; oil and moisture affect it hardly at all. Neoprene itself is subject to some corona deterioration. But when properly compounded and vulcanized, it resists corona enough so that it will not crack in automotive ignition service.

The third type illustrated is the same as the second, except that an open weave of high-tensile glass yarn separates the rubber and the neoprene. (It was originally developed for military aircraft service.)

Adding the inner braid mechanically compresses the rubber insulation around the conductor. This considerably improves dielectric strength and corona resistance of the cable. Additionally this braid imparts mechanical ruggedness, useful where wires are pulled into a complete shielded harness and where moisture is to be sealed off by compression grommets.

Since this aircraft-type cable obviously is the most expensive, it is recommended only for particularly severe truck and bus service where experience shows it necessary. The neoprene construction stands up much better and longer than the braided and lacquered cable and actually costs no more.

Neoprene-sheathed cable is a must for jobs where the engine is subject to extreme moisture, particularly road splash together with liberal quantities of calcium chloride. Also connections at each end of the wire must be protected by neoprene or vinylite nipples or boots. Recommended protection at the spark-plug end consists of a snug fitting boot gripping the cable about ½ in. back of the terminal and extending down over the plug porcelain at least ¼ in., with a snug fit on the porcelain. Protectors of neoprene are preferable for corona and heat resistance, designed with as little free air space as possible inside the boot.

Stay away from metal cans as spark-plug enclosures as well as large bulbous boots. Condensation in such cases can make more trouble than rain or road splash.

A new type of conductor, introduced several years ago, consists of small-diameter, seven-strand stainless steel wires in place of the traditional 19-strand copper wire for ignition cable. It has the required mechanical strength and many claims were made for this type of conductor because of its lower capacitance and higher electrical resistance. But its high cost and difficulty in connecting conventional terminals are serious disadvantages of the steel conductor.

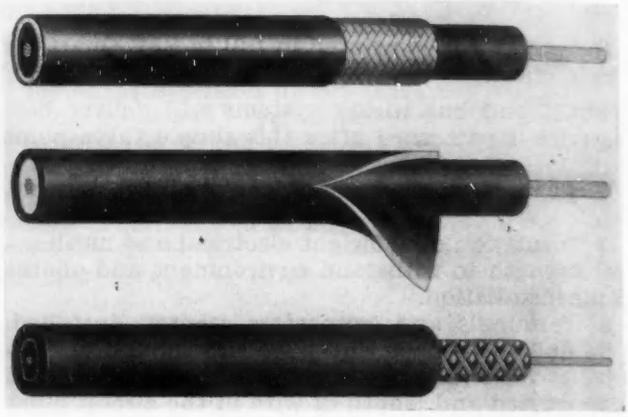


Fig. 1—These ignition cable types differ as to covering on the rubber insulation. The top one has a lacquered cotton braid cover; the middle one, neoprene; the bottom one, an open weave of glass yarn between the insulation and neoprene covering

Theoretical reduction of capacitance with the steel conductor is about 25%, from 40 mmf to 30 mmf per ft. But in actual practice the difference would be no more than 10% since the cable installed on the average vehicle is not close to the ground for its entire length. Where critical ignition design demands reduced capacitance of an installation, more can be done by shortening the leads and increasing the distance between the leads and ground than by changing to steel core cable.

Second feature of the steel conductor is its relatively high resistance, claimed to reduce spark-plug erosion. Resistance of copper ignition cable about 18 in. long is 0.0066 ohm, compared to 0.6 for the steel cable. While the steel conductor has almost 100 times the resistance of the copper, the actual added resistance in wire of this length is only about ½ ohm—not enough to affect spark-plug life.

Two other items would seem to rule out the steel conductor. First, it costs too much. Second, the small-diameter steel core with only seven strands is not satisfactory for conventional automotive terminals, which make contact by a prong piercing through the insulation from the side. Also, most radio suppression resistors are designed to attach to the cable end by screwing the contact member into the end of the core. Steel conductors will not hold this type of connection, requiring special terminals costing more than present types.

### Starting Motor Circuits

Several types of cable construction used for starting motor circuits are shown in Fig. 2. The conductor may consist of either concentric strand or rope strand. Rope strand is larger in diameter for the same cross-sectional area of copper than concentric strand and is more expensive. But since it is more flexible, the rope strand is used for installations where the flexibility is worth the money. Normally the concentric construction is suitable.

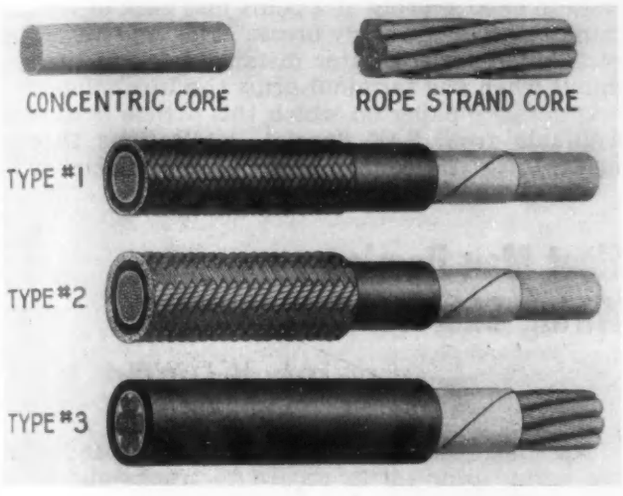



Fig. 2—Starting cable may be constructed with concentric or rope strand. Insulation for Type No. 1 consists of rubber covered with a varnished and lacquered cotton braid; Type No. 2 uses a Seine twine braid; rubber without braid is used for Type No. 3

Insulation as shown in the first type consists of rubber, covered by a cotton braid, usually treated with a black wax or saturated with asphalt varnish and covered with lacquer. The Seine twine braid used in the second type, Fig. 2, is a heavier and tougher covering. The third type is rubber insulated without braid. In this case the rubber must be mechanically tough, thus more expensive than the compound used underneath the braid.

This third type resists acid much better than the first two, but it is not used often because of its higher cost. Where the battery end of the cable is exposed to acid, a vinylite tape wrapped over the cable for the required distance usually is the better remedy.

On all trucks the conventional connection post is used on the battery with the passenger-car type clamp terminal. This type of connection usually corrodes and forms a high resistance film between the battery post and the terminal, particularly on the positive post. The contact surface of both post and terminal should be cleaned thoroughly with emery cloth or a scratch brush, then petrolatum applied to these surfaces before making the connection.

On buses the connection to the battery usually is made at the side of the battery with a conventional stud, to which is attached a standard lug-type terminal. Since it is away from the top of the battery, this connection is less subject to corrosion. It readily lends itself to parallel connections and also to use of booster batteries for emergency starting.

### Power and Lighting Circuits

Power and lighting circuits make up the biggest part of the vehicle's wiring. Fig. 3 shows several kinds of cable for this use.

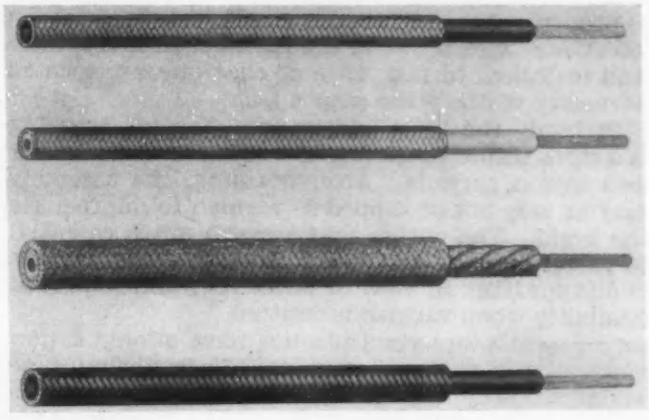


Fig. 3—Four types of power and lighting cable shown are, from top to bottom: (1) rubber insulation with lacquered braid covering; (2) flexible plastic insulation; (3) asbestos insulation; and (4) paper-and-cotton thread braid

First and most conventional is a rubber-insulated cable with a lacquered braid covering. The braid provides a tough protective cover which withstands a reasonable amount of abrasion; it has a high resistance to cutting and tearing when the cable is dragged over sharp surfaces during installation. Various combinations of color and tracer threads in the braid identify circuits conveniently and inexpensively.

The second type, in Fig. 3, resembles the first, except that the insulation is a tough, flexible plastic. Wartime experience with this construction on aircraft and Ordnance vehicles proved it to be superior to rubber, though it costs much more. Since plastic does not corrode copper, a tinned coating or paper separator between the conductor and insulation is unnecessary.

The third type is an asbestos insulation which can be built in different ways. Construction shown is felted asbestos with a braided asbestos covering, treated with a suitable flameproof and heat-resistant material. This type of wire is generally more expensive than the first two; it's used only where the wire is exposed to extremely high temperatures or where completely flameproof insulation is required.

Superior resistance to abrasion is exhibited by the fourth type. It features a heavy braid consisting of

paper and cotton threads woven together. Twisted kraft paper threads generally have greater resistance to abrasion than cotton or other textiles.

Even the proper kind of wires for the job must be held together in proper relationship during assembly so that they are protected to prevent damage during service.

Selection of the right wiring harness covering should depend on location of the harness in the vehicle, amount of abuse given the wiring assembly while assembled in place, and environment conditions in operation.

By far the most rugged protection is the nonmetallic loom. It affords ideal protection where the harness runs underneath the vehicle, subjected to road splash and mechanical abuse. Despite its high cost, this covering is justified.

The loom offers another convenience if loom size is properly chosen. It is not too difficult to string an additional wire or two in the harness, after it is built and installed, to take care of that one unexpected accessory which often pops up.

Probably the most widely used harness covering is a woven braid consisting of a combination of paper and cotton threads. After braiding, the assembly may or may not be dipped in varnish to impregnate the braid. The notion that varnish dip is essential to preserving the braid and protecting the harness is disappearing in view of lower cost and improved flexibility when varnish is omitted.

In recent years vinyl plastics have offered a new material for wiring harnesses. It is a thin tape wound spirally around the harness. The tape is applied with a generous overlap; then the harness is exposed to a temperature of about 250 F which softens the tape and seals the lapped portions.

Cost of the tape about equals the braid, and both are cheaper than the loom. The tape offers ideal protection for under-chassis installations meeting up with road splash. While the tightly-stretched tape at first looks too thin and fragile, it is suprisingly tough. Of course it can't be used where temperatures exceed 200 F.

Since oils, fuels, and various solvents used in washing down engines do not affect the vinyl tape, this covering is highly desirable for wiring in engine compartments—if temperatures are not too high for the material.

Currently available on the market is a flexible metallic conduit harness, designed for diesel engine compartments, which completely protects the wire from all contact with fuel and other harmful fluids. In addition, it is ventilated by suction connection to the engine. Flow of air carries away any moisture in the harness tubing and also helps cool the cables.

Having selected the wire gage size and construction for the job, next step is choosing a terminal type and making a sound connection. Both the soldered and compression or crimped types of connection are used widely. Both have advantages and disadvantages, neither is foolproof.

When considering which type to use, the wiring engineer must first know the conditions under which the wiring assemblies are to be built. For example, if the harnesses are to be supplied by an outside company, soldered terminals usually get the nod. For a volume producer soldered terminals usually cost less and the soldering operation is more easily controlled than most crimping processes.

Where the vehicle builder makes his own wiring assemblies, crimped terminal attachments are more satisfactory to maintain quality and actually cost less than soldered ones. This is so because this wire department usually will not be set up to attach and solder as efficiently as the wiring assembly specialist.

If the wiring system design requires some terminals to be attached to wires after they have been installed on the vehicle, crimped terminals should be used. It's more convenient to use them and they eliminate the hazard.

A feature important in either type of terminal, when attached to smaller gage sizes of wire, is that the terminal grip the insulation in addition to making proper contact with the conductor. If terminals grip only the exposed conductor, the conductor will tend to bend sharply at a point just back of the terminal, inviting an early break. Flexing stresses are distributed for a greater distance back of the terminal when the terminal grips the insulation.

(Complete paper on which this article is based is available from SAE Special Publications Department, Price: 25¢ to members, 50¢ to nonmembers.)

# Fleet Man Decries Wiring Shortcomings

Excerpts from discussion by **H. L. Willett, Jr.**
The Willett Co.

Our impression from Mr. Wolcott's paper is that the wiring problem in regard to trucks and buses have been pretty nearly solved in many respects. In our experience we find room for considerable improvement.

Often chronic failures are placed in the category of exceptional cases as concerns electrical as well as other phases of truck construction. We have been readily receptive to recommendations from manufacturers and have complied with many of those mentioned by Mr. Wolcott. But we still are confronted with many wiring system failures, like the ones shown at right.

We would like to suggest the following:

1. Better means should be devised for fastening conduit and junction boxes.

2. Waterproof and moisture-proof boxes should be made more easily available.

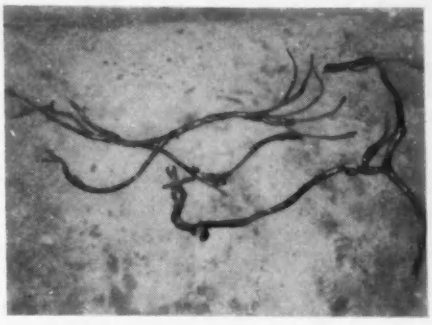
3. Better methods of clamping wires and looms should be designed to prevent excessive breakage from vibration.

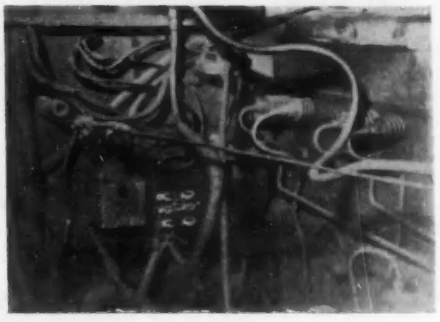
4. Increased standardization of connectors between tractor and trailer would result in greater convenience and economies. We have about 600 trailers that are interchanged with various tractors at the rate of approximately one and one-half times each day, which necessitates standard connectors on all units.

5. We also feel that it would be of particular value if manufacturers of wiring equipment would publish wiring manuals explaining and illustrating proper wiring procedures that could easily be read and understood by the average shop mechanic.

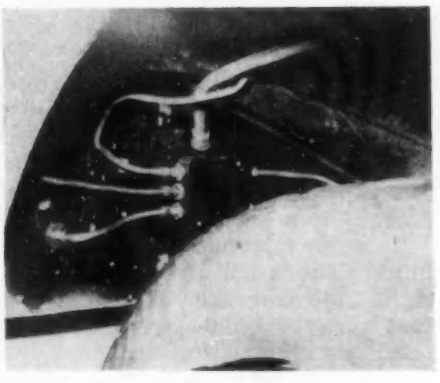
# One Fleet's Wiring Troubles

(Illustrations for "Fleet Man Decries Wiring Shortcomings"—excerpts from discussion by H. L. Willett, Jr., The Willett Co., p. 52)

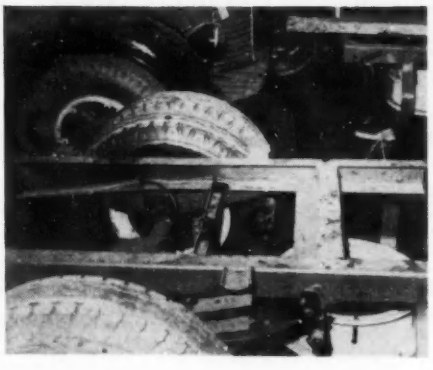


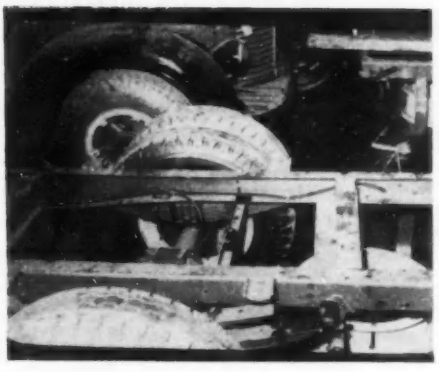


In the first photo is shown ignition wiring just removed from a tractor that operated less than three years. The plastic tape covering is badly cracked, falling away in many places. The wires are badly oil-soaked and have been repaired and retaped many times. Evidently this failure is due to heat. Wiring in the next illustration comes from under the hood of a diesel tractor, scheduled for a rewiring job. The loom failed in several places and here too many of the wires have been repaired and taped.



This is a view of wiring on the four-wheel trailer of a petroleum train. Despite use of conduit and junction boxes, this wiring failed miserably and required much temporary work to keep the unit rolling. The unit is about five years old. In for a rewiring, this unit will go out looking like the one at the right. This is typical of the wiring we do on our gas trains.





Here is how we receive wiring from a manufacturer. In the next photo note how we protect the wiring with a loom. Yet it has been our experience that even with this protection, wiring fails in three to four years due to vibration, dirt, oil, calcium chloride, and moisture.

# HIGH-SPEED

BASED ON PAPER* BY

**O. D. Treiber**

Consulting Engineer
Hercules Motor Corp.

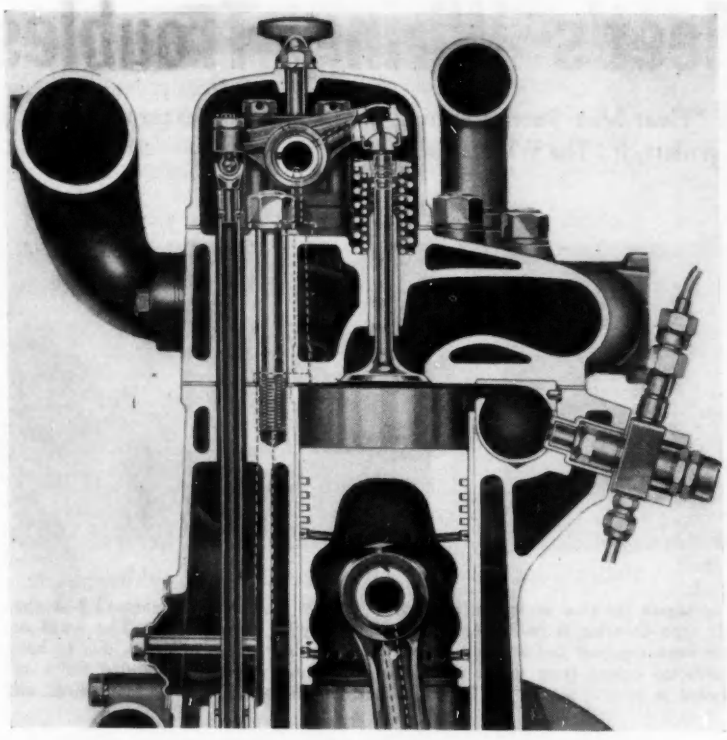


Fig. 1—This Hercules diesel combustion chamber consists of a sphere located at the side and top of the cylinder. Into it all the combustion air is tangentially pressed from the cylinder by the flat top piston, coming up to just mechanical clearance with the flat cylinder head

TODAY'S high-speed heavy-duty diesel engines must toe a high and narrow path of combustion and injection requirements. Failure to meet stringent standards of thorough fuel-air mixing and precise injection timing will drop performance and efficiency to a low level.

As engine speeds increase, so do the problems of mixing fuel with air to produce combustion at the right time and rate. It also gets tougher to prevent fuel spray droplets from coming against or even near the combustion chamber walls. Neither fuel nor air will hunt each other out in the combustion chamber; and fuel exit through the exhaust represents waste.

This job of mixing fuel and air in high-speed engines is colossal. Visualize the basic elements of this combustible mixture as simple marble balls in the same proportion on a molecular basis. On a volume basis here is how the air constituents would break down: 67.6% nitrogen (as far as combustion is concerned, nitrogen is inert—like the ashes in your coal fire); 14.8% oxygen. Oxygen must unite with the fuel, made of 15% hydrogen and 85% carbon by weight. Relative volume of liquid fuel to combustible air is very small. But assuming they are separate gases, their percentages of the whole mixture would be carbon, 5.6%, and hydrogen, 12%. Together with the oxygen and nitrogen this comprises the entire mixture—a total of 100%.

Now if these four constituents are placed in a bowl and stirred to bring the oxygen balls in contact with the hydrogen and carbon balls, we find the preponderance of inert nitrogen balls interfering with our mixing operation. Especially is this so when the job has to be completed in a very short time—about 0.001 sec. It takes a terrific amount of stirring and turning to do this job. Yet that's what a high-speed diesel engine must do.

The diesel's combustion chamber does the job of the gasoline engine carburetor. But in the diesel, mixing must not only be fast—it must be done at cyclic intervals and at the right time and rate for uniform combustion, and to use a high percentage of oxygen in the air. And combustion must be completed early enough in the expansion cycle to give the highest possible expansion ratios of the gases before the exhaust exist opens.

Combustion air, pocketed about the combustion chamber so that it cannot be brought into intimate contact with the fuel (before the piston proceeds beyond about 20 crankshaft deg of its expansion stroke), is failing to do its share of the power-producing potential. Result: low engine capacity or indicated mean effective pressure together with high fuel consumption, high exhaust gas temperature, and a heavier, more expensive engine.

One measure of efficiency of air utilization for combustion is the excess oxygen in the exhaust gases. This must be compared with the combustibles remaining in the exhaust gases—carbon monoxide, CO; hydrogen, $H_2$; methane, $CH_4$; ethane, $C_2H_6$; and free, sooty colloidal carbon which gives rise to black or brown exhaust called "diesel smoke."

This carbon is lost, wasted fuel. It may amount to

* Paper "Diesel Engines of a High-Speed, Heavy-Duty Type for Automotive Service," was presented at SAE National West Coast Meeting, San Francisco, Aug. 19, 1948.

# DIESEL ENGINES SATISFY
# Tough Combustion, Injection Needs

as much as 15% by weight of the total fuel being injected into the engine—or 15¢ lost on every fuel dollar spent.

Obviously the job of mixing fuel and air in a diesel engine to prevent such waste isn't easy. Doing it mechanically within the combustion chamber—as with a fan to stir up the mixture—is not possible because no known metals can withstand and operate, uncooled, at these temperatures of about 4000 F. For this reason it is customary to shape the combustion chamber so that it produces turbulence of the combustion air which does the mixing. Some such designs have been attempted with shrouded inlet air valves and shape of inlet air passageway to set the air in whirling motion in the cylinder. But most projects use the moving piston to produce needed air turbulence; a great many different ones have been designed and built.

Let us examine further what combustion air turbulence is necessary for proper fuel and air mixing and for high-percentage use of the oxygen. We can assume that the mixture should have at least three or four "stirs" during the injection and combustion period of an engine running at 2500 rpm. (This is not an excessively high speed because we now have in high production engines operating at 3000 rpm full load.)

Fuel injection duration of such an engine at this 2500-rpm speed is about 12 crankshaft deg. The ignition lag varies with different fuels, but may be assumed for this analysis as being 8 crankshaft deg —a fair average for a high cetane fuel. The combustion period at full engine load (commercial rating) should be completed at 18 deg ATDC of the crank to get the highest possible expansion ratios of the gases.

On this basis two-thirds of the fuel is injected into the combustion chamber before ignition; combustion then continues for another 18 deg. This totals 26 deg to complete the mixing of combustion components. During this period the fuel and air mixture should have three to four thorough stirrings. We may assume that a single stirring consists of one complete cycle of the turbulence process.

If this air motion is circular, there would have to be three or four complete revolutions of the air in 26 crankshaft deg; at a speed of 2500 rpm this takes place in 0.00173 sec. Actual combustion occurs in 0.0012 sec. Circular velocity of the air required to meet this challenge—of say three and one-half revolutions in 26 crankshaft deg—is 50 times crankshaft speed.

Obviously it is desirable, if not essential, to have air turbulence a fixed ratio to crankshaft speed. Automotive, marine, and many industrial engines operate over a wide speed range. This imposes an-

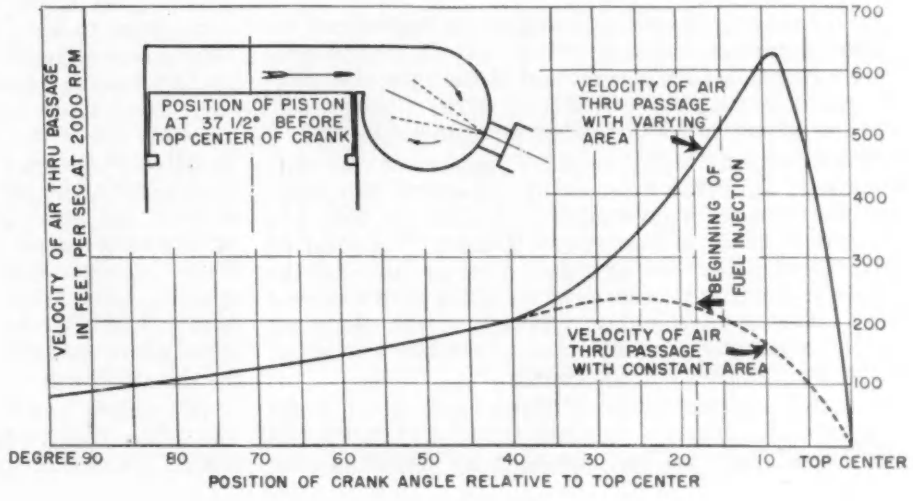



Fig. 2—Air forced from the cylinder into the combustion chamber by the piston attains a top speed of 625 fps at 2000 rpm

other cardinal problem for the high-speed diesel—mixing the fuel with the air for combustion at the right time and rate at all speeds. It must not happen too rapidly; this results in excessive rate of gas pressure rise, producing objectionable fuel knock.

Another tough job with high-speed diesels is injection of fuel into a combustion chamber—particularly with relatively small engines for automotive and marine service. The combustion chamber is often smaller than a golf ball. Fuel shoots in at a speed of 150 to 200 fps to atomize the fuel properly.

Yet fuel droplets must be prevented from coming in contact with, or even close to, the combustion. chamber walls. If they do, the droplets stick to the surface, slowly decompose, and give off oxidized hydrocarbons—largely aldehydes, including formaldehydes. These do not burn; they are expelled in the exhaust to create a foul smell and bluish or whitish smoke. Often accumulated carbonaceous material in the combustion chamber jeopardizes continued successful operation.

### Cause of Smoke

When droplets do not touch, but only closely approach the combustion chamber walls, again they only partially oxidize. The product—foul-smelling exhaust and bluish smoke.

If combustion chamber walls are hot enough, they will repel the fuel droplets from the surface and crack or decompose the fuel molecules. The process occurs regularly in the once-popular semi-diesel engine. Trouble stems from the fact that these combustion chamber walls cannot be maintained at some predetermined high level of temperature (considerably above 600 F) with varying loads and speeds required of practically all modern engines.

If wall temperature is high enough to perform the desired function of repelling, cracking, and gasifying fuel sprays at low loads and speeds, then the walls burn up at high loads and speeds. At the other extreme—proper temperature at high load and speed—the walls are too cold at low speeds and loads. Additionally, often an engine has to be started from a cold condition and operated while these surfaces get hot. Many are the cases where a bluish cloud of exhaust smoke from an engine on test obscured the entire factory.

Maintenance as well as combustion influences injection equipment design. How can an engine produce a return on its investment if the operator cannot easily clean and adjust fuel spray nozzles, and time or adjust other injection equipment parts?

Small holes of a multi-orifice nozzle are not self-cleaning. Only the most skilled operator can ream and clean them. To remedy this trouble we designed the pintle type of fuel spray nozzle. The closing valve stem protrudes through a large hole in the nozzle in which it oscillates to keep the hole free and clear. This type of nozzle virtually never plugs up. But if required, any one can assemble and even polish the nozzle with no trouble.

Much of the finalizing of these high-speed diesel "musts"—combustion chamber shape and fuel spray—emerges from patient cut-and-try experimentation. For example, the Hercules diesel engine combustion chamber was tried with 63 different shapes and fuel spray arrangements, even after conception of the basic idea. Fig. 1 shows a sectional view of this combustion chamber.

The curve, Fig. 2, shows the velocity of the air entering the spherical chamber on crank angle positions. It should be noted that the piston passes across the passageway to the sphere, which we call the auxilary combustion chamber. Thus the area of the passageway is reduced on the piston's upward travel. About 60% of the total combustion air is in the cylinder when the piston begins this restriction of the passageway. This fact is readily understood when comparing the volumes in the sphere and cylinder at this piston position.

The curve is made for an engine speed of 2000 rpm and shows a maximum velocity of air entering the sphere of 625 fps or 7 miles a minute during the injection period. At 3000 rpm it is 50% greater, close to the speed of sound at sea level atmospheric pressure.

It is calculated that the air revolves in the sphere at about 50 times crankshaft speed regardless of rpm. The fuel spray is arranged at 16 deg below the horizontal and has an 8 deg included angle of spray with a static nozzle opening pressure of 1650 psi. It is significant to note that this is the turbulence velocity we deducted from the above analysis of these requirements for three and one-half "stirs" for each fuel-air charge in the number of crankshaft degrees for injection and combustion.

It should be pointed out that the combustion air turbulence velocity is always a direct ratio of engine rpm—about 50 revolutions of the air to each crank revolution. This feature provides an excellent control of the rate of mixing the fuel with the combustion air to produce the proper rate of combustion, regardless of engine rpm.

Furthermore, this combustion chamber has, what we believe to be, a unique feature. Due to the high speed of revolutions of the air, the centrifugal force at the existing air density (about 500 psi.) renders the layer of air next to the combustion chamber wall more dense than the fuel droplets or their component elements. This tends to confine them towards the center of the sphere, preventing their approaching the walls to cause exhaust smoke and smell.

The fuel spray droplets entering the turbulent air appear to have sufficient energy from their velocity to carry them through the air stream adjacent to the nozzle. But before they reach the opposite wall they have lost considerable of their velocity, possibly all of it. These fuel droplets are torn into smaller particles as they are cracked, gasified, and mixed with the air toward the center of the sphere where, the first phase of combustion begins and where only a small amount of fuel is burned. From here the combustion proceeds outward on its second phase. The final or third phase occurs with extreme rapidity, as it must, when the fuel air and partly burned constituents emerge from the sphere to the cylinder.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

# Design Trends in HEAVY DUTY BRAKES

BASED ON PAPER* BY **Ralph K. Super**
Brake Division Engineer
Timken-Detroit Axle Co.

BRAKE design progress in the heavy duty vehicle field indicates need of concentration on:

- Control systems with automatic power distribution to compensate for load variations,
- Lining and drum materials with improved performance at higher temperatures,
- Increasing braking capacity through cooling,
- More use of supplementary brakes to assist wheel brakes, and
- Adjusting mechanisms which will automatically maintain clearance between linings and drums.

Should principles of energy absorption by electrical or fluid mediums be introduced, most of the above problems would certainly need to be reconsidered.

During the past 10 years more progress has been made in vehicle brakes since the introduction of four wheel braking systems. Design of actuating systems has also made considerable progress, and demand for less driver fatigue has accentuated this trend toward improvements.

Ten years ago brake application time of 0.5 sec for buses and 0,7 for tractor-trailer trains was considered good. Then brake release times were 0.6 for buses and 1.5 sec for tractor-trailer combinations.

Today times have been reduced from one-half to one-third, and systems in the development stage promise even greater speeds of application and release.

Best brake performance is achieved when the shoes contribute equally. This usually results in equal rate of lining wear on the shoes. In the pivoted anchor pin, fixed journal cam type, the lift is the same for both shoes and wear is equal.

Symmetry of shoe action is a new approach to obtain equal work, and with it has come the forward acting shoes. Examples are the Wagner FR and Hi-Tork, both hydraulic; Dodge two cylinder brake, the Bendix Twin-Plex, and the Timken-Detroit Dual Primary, one for hydraulic and the other air.

This is as revolutionary as was the change from band brakes to shoe brakes, and increased brake output and life will be a feature on new vehicles put into service.

Additional work capacity has been added to modern brakes by improved cooling. Natural circulation of air over the inner and outer surfaces of the drum results from removing the dust shielding. In logging operations particularly, water is used to increase cooling, but this adds a weight penalty.

**Concluded on Page 73**

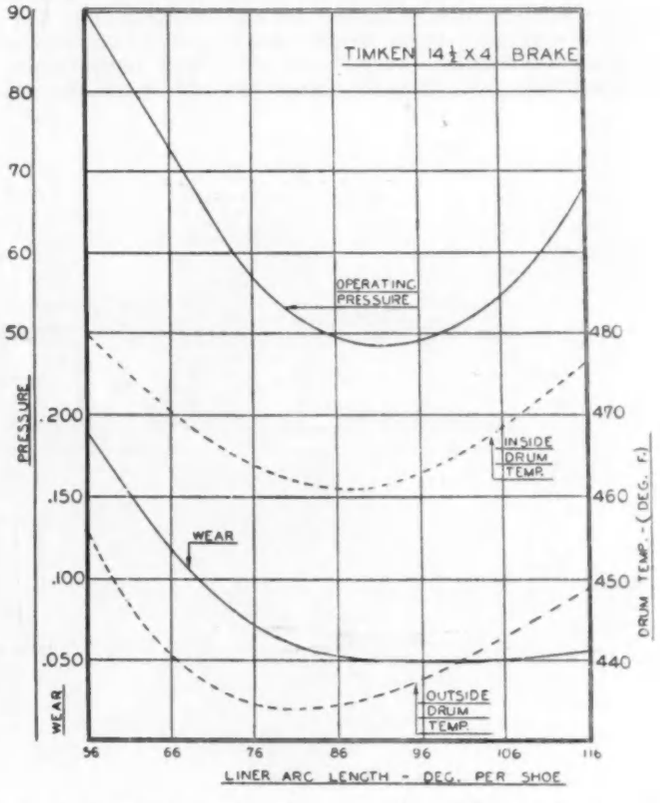



**Fig. 1—Temperatures, rate of wear, and air pressures decrease as linear length of brake lining is shortened**

*Paper "Heavy Duty Brakes," was presented at SAE National West Coast Meeting, San Francisco, Aug. 18, 1948.

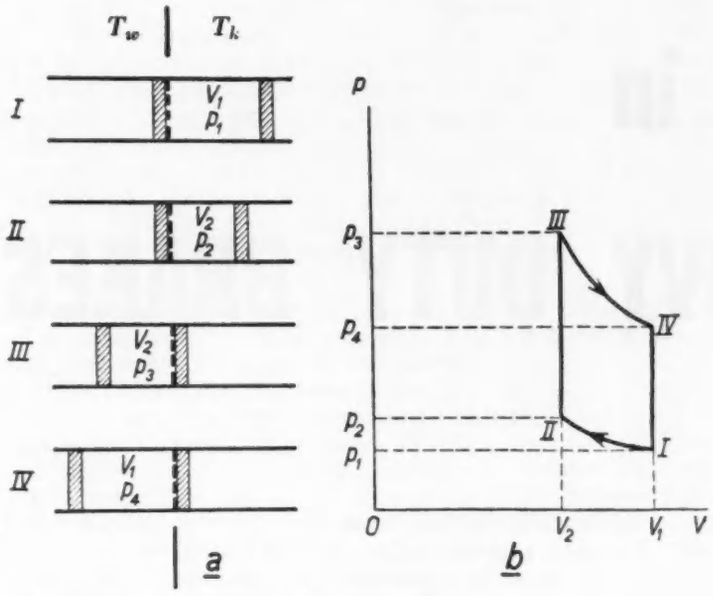



Fig. 1—Ideal cycle diagram for air engine

# Dutch Labs Revive Hot-Air Engine Idea

Based on paper by

**C. G. A. ROSEN**

Caterpillar Tractor Co.

PHILIPS laboratories at Eindhoven, Holland have developed a promising new powerplant based on the old air-engine concept. With modern engineering knowledge, they have surmounted the difficulties that made the old Ericson and Stirling engines impractical.

Fig. 1 illustrates the ideal cycle on which the Philips engine is based. Two pistons operate in one cylinder. The right half of the cylinder, its piston, and any enclosed air are at a low temperature, $T_k$. The left half, its piston, and any enclosed air are at a high temperature, $T_w$. At I, all the air is in the cold space, occupying maximum volume. From I to II, the cold piston moves in, compressing the air isothermally to the minimum volume. From II to III, the air moves at constant volume from the cold to the hot space. From III to IV, the air expands isothermally, doing work on the hot piston. From IV to I, the air moves at constant volume back to the cold space.

Since the isothermal expansion takes place at high temperature and the isothermal compression at low temperature, there is a surplus of work available.

The cycle is carried out in the external-combustion engine diagrammed in Fig. 2. The cold end of the cylinder is cooled by the cooler, K, and fins. The hot end is heated by the heater, H. In passing from the cool space to the hot space, the air flows through the cooler to a regenerator, R, where it picks up heat. Beyond the regenerator, it picks up more heat in the heater and reaches the temperature $T_w$ on entering the hot space. (The heater is a heat exchanger which receives its heat from the burner B.) On the return trip, the air passes through the heater, gives up heat to the regenerator, and is cooled to temperature $T_k$ in the cooler.

Advanced knowledge of high-temperature materials, heat transfer, and fluid mechanics makes possible high engine efficiency.

Ideal piston movement is approximated in the practical engine by operating the pistons 90 deg out of phase.

The engine has at least four advantages:

1. Relative freedom from high torque reactions minimizes torsional vibration.
2. Torque rise ratios as high as 3:1 can be obtained.
3. Fuel consumption is lower than in internal-combustion gasoline engines—although higher than diesel engine comsumption..
4. Lack of explosions and high impact loading results in quiet operation.

(Paper "Development Trends in Mobile Powerplants," was presented at SAE Indiana Section on Feb. 12, 1948 and at SAE Kansas City Section on March 9, 1948. This paper is available in full in mimeographed form from SAE Special Publications Department. Price: 25¢ to members. 50¢ to nonmembers.)

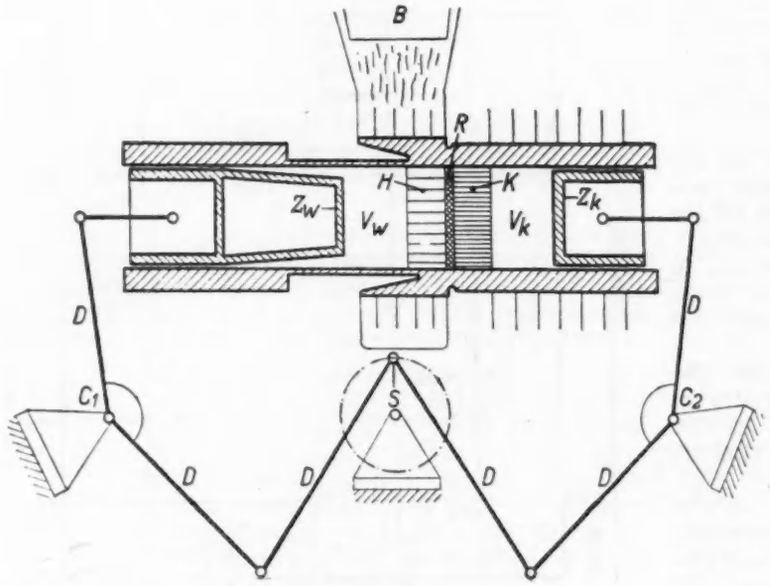



Fig. 2—Schematic diagram of Philips air engine

# GMC Booster Heats Coolant to 155-170F

From paper by

**E. T. TODD**

GMC Truck & Coach Division

THE booster heater now in common use on GMC buses contributes heat to the engine cooling system when

needed to help it warm the coach and keep engine-jacket water temperatures up to the 155-170F range.

Water from the engine cooling system is pumped to the booster heater—which is actuated only when the water temperature drops to 155F—and then flows to a diversion valve. If the passenger-space thermostat calls for heat, the diversion valve sends the water on to circulate through the coach-heater core and then return to the engine. If the thermostat is not demanding heat, the valve directs the water flowing from the booster heater back to the engine.

Fig. 1 shows the combustion unit. Combustion begins at the right end, that end becoming incandescently hot and transferring heat radiantly to the water jacket. Hot gases from the combustion chamber pass through turbulators which direct the gases to the surrounding wall, where they give up more heat to the jacket water.

Four or five switches control the booster system. The engine-temperature switch turns on the booster heater when engine-jacket water temperature drops to 155F and turns it off when temperature rises to 170F. The ignition-cutout switch shuts off the heater fuel supply if the combustion does not occur when the heater is actuated. And the current heats a warp switch in about 60 sec, causing it to shut down the combustion unit and light a telltale light on the dashboard.

If the combustion heater fires and runs its jacket water up close to boiling, the limit switch cuts off the heater's fuel supply. The optional fifth switch is another high-temperature-prevention device, the low-water switch, which can be located wherever excess temperatures first may be detected. The switch opens the power supply line when it detects excessive temperatures. (Paper "Booster Heaters for Internal Combustion Engines," was presented at SAE Midcontinent Section meeting, Feb. 6, 1948. This paper is available in full in mimeographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

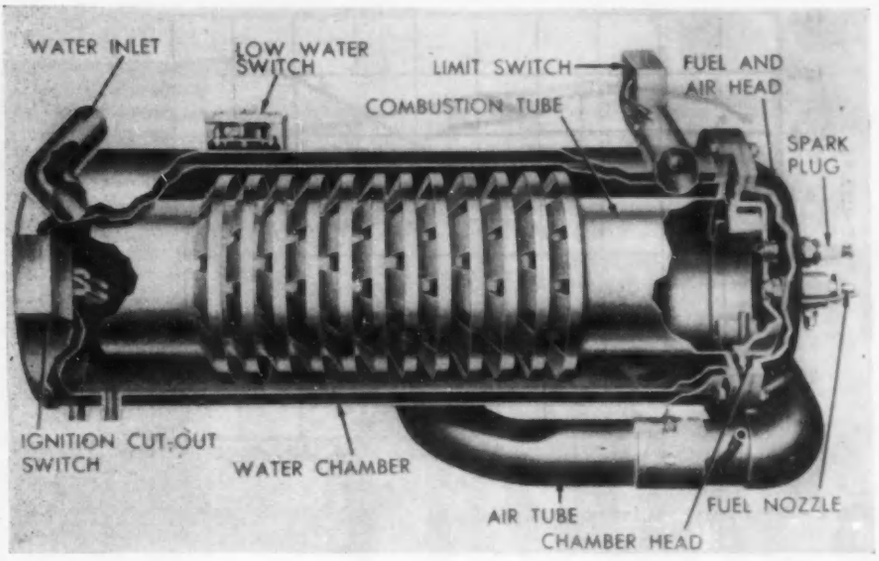



Fig. 1—Cutaway view of booster heater combustion unit

## Willys Compact Six Has Ventilated Case

Excerpts from paper by

**PAUL HUBER**
Willys-Overland Motors, Inc.

THE new Willys passenger car engine is a short-stroke, compact six. It has a 3-in. bore, 3½-in. stroke, and displaces 148.4 cu in. As usually happens with a small engine, the accessories are out of proportion to engine size.

The complete powerplant, Fig. 1, weighs 542 lb. But the clutch, bellhousing, transmission, and overdrive account for 131 lb, reducing engine weight to 411 lb. Since the electrical system weighs 55 lb, the bare engine weighs 356 lb. Without clutch and transmission, the engine measures 29½ in. long and 20 in. high.

Engine design is generally conventional. Wide overlap between the journals of the four-bearing crankshaft produces high stiffness. Both main and rod bearings are removable shells, thin babbitt lined. The T-slot pistons carry two compression rings and one oil ring above the pin. All bearings, valve tappets, and timing

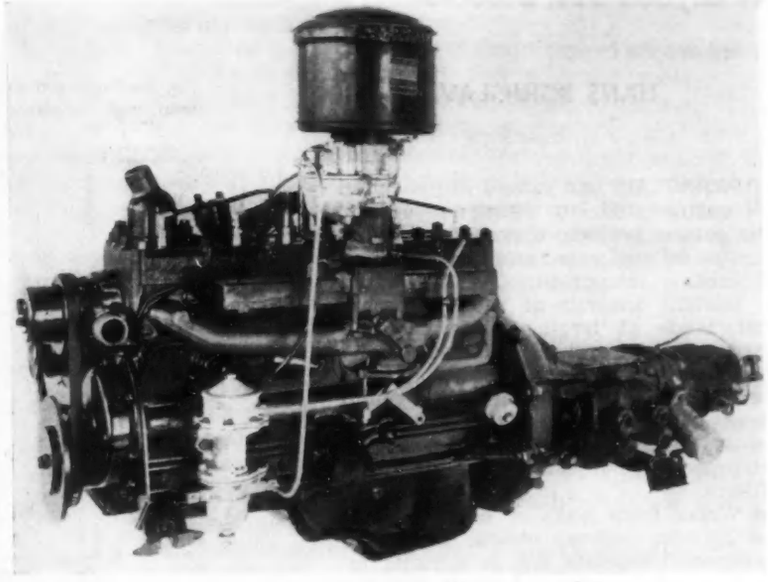


Fig. 1—Willys-Overland 148-cu in. 6-cyl engine

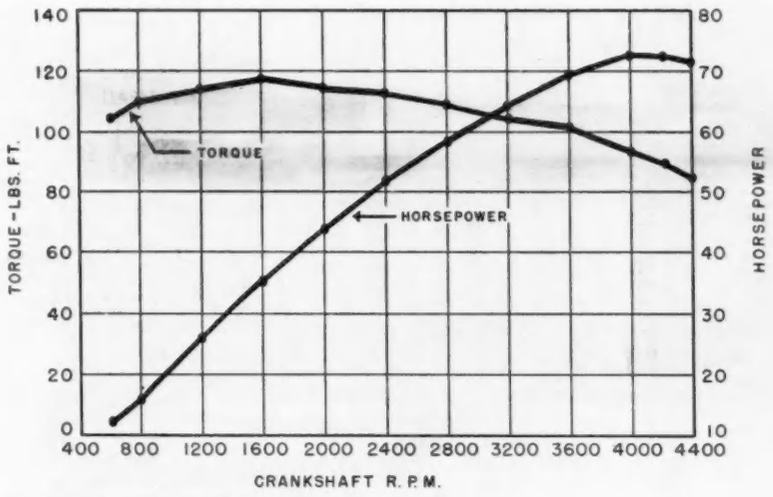



Fig. 2—Rated power and torque of the Willys six

gears are pressure lubricated. Wrist pins are splash lubricated.

Uncommon features of the engine stem primarily from its compact design. The cylinder bores are siamesed in three pairs. The full length water jacket is essentially conventional but narrower than usual in some spots.

Third important variation is use of positive crankcase ventilation as standard equipment. Air is fed into the engine through the oil filler tube after it has gone past the air cleaner. Air is removed from crankcase through a tube connected from the valve cover to an automatically-controlled valve, mounted just below the carburetor. This positive ventilation system minimizes crankcase deposits and makes for an overall cleaner engine.

Rated power and torque of this engine are shown in Fig. 2, corrected to 29.45 in. Hg and 60F dry air. These are the best values which we can get consistently. (Paper "The Willys-Overland 148 Cubic Inch Six Cylinder Engine," was presented at SAE Summer Meeting, French Lick, June 9, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

■

# Operating Economies Analyzed for Diesels

Based on paper by

**HANS BOHUSLAV**

Engineering Controls, Inc.

OPERATORS can extend life of diesel engines and cut maintenance costs by getting periodic diagnoses of lubricating oil and water and by controlling operating temperatures.

Careful analysis of the lubricating oil, made at frequent intervals and properly interpreted, will disclose the extent of the following conditions:

- Fuel dilution due to injection pump leaks or malfunction of fuel nozzles.
- Soot from smoke—due to overload, improper fuel injection, or clogged air filters.
- Water from leaks or condensation.
- Cylinder sleeve, piston, and ring wear and deposits due to sticking or improper lubrication, dirty air, and insufficient lubrication of pistons.
- Wear or overheating of bearings because of improper installation or lubrication, or faulty material or engine operation.
- Lube oil oxidation due to excessive temperature, clogged filters, or insufficient flow—especially for piston cooling.

A systematic procedure and uniform report on lubricating oil analysis will pay dividends in better performance, longer intervals between overhauls, and reduced maintenance costs.

Analyzing water from the engine cooling system will determine the extent of scale and corrosion in the jackets. The operator can then anticipate such conditions and minimize them by appropriate water treatment and changes in operating temperatures. It is logical to have the same laboratory handle both lube oil and water analyses.

There is another way to improve engine life, lengthen periods between overhauls, and reduce routine attention. Maintaining constant high temperature of cooling water—preferably near the fluid's boiling point—will do it.

Temperatures of jacket water and lubricating oil should be kept high to prevent condensation within the engine. This fact is generally recognized, although how high the temperatures should be is still a point of contention. At present most engine manufacturers recommend jacket water temperatures up to 180 F. Lube oil temperatures usually are specified at 140 F to 160 F.

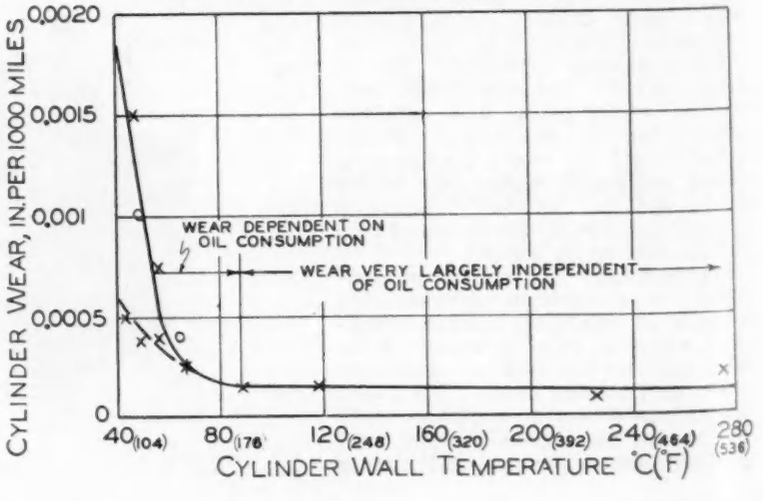
Some large-engine makers still limit water and lube oil temperature from 120 F to 140 F, although one 3000-hp engine is now operating successfully with "vapor phase" cooling at 225 F water temperature and 200 F oil temperature.

Benefits from higher temperatures were shown in single-cylinder tests made in the laboratory of the Institute of Automobile Engineers in England. Note in Fig. 1 that wear was slight and practically constant from 176 F to 536 F. Below 176 F, wear increased, at first gradually, then very rapidly.

The dotted line indicates the wear

**Continued on Page 85**

Fig. 1—Single-cylinder engine tests showed that low wall temperatures accelerate wear, high temperatures keep wear down. The dotted line resulted from allowing additional lube oil to reach the cylinder walls



# TECHNICAL COMMITTEE PROGRESS

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## First Changes Expand Aero Drafting Manual

UNLIKE most publications of its type, the SAE Aeronautical Drafting Manual is kept fresh, up-to-date with the art by its author Committee. A revision package just issued adds a '48 lustre to this two-year old Manual.

Owners of the original volume can modernize it with the revision kit made up of 43 new pages. The Dewey decimal page-numbering system simplifies the job. New purchasers will receive the revised Manual complete.

The new pages are largely additions. Committee members have expanded the Manual section on springs and the one on definition of terms. The latter particularly will help engineers, draftsmen, and shop men better understand each other in their "language of the blueprint."

Also clarified are the ways of ordering different kinds of materials. For example, sheets or strip stock of steel, aluminum, and zinc each are specified by a different gage for thickness. New information added to the Manual spells out these differences together with references to tolerance standards.

Chairman of the SAE Aeronautical Drafting Manual Committee, O. E. Kirchner, American Airlines, Inc., has steered the work of his conferees with one objective in mind: that the Manual serve the industry—especially engine, propeller, and accessory manufacturers and airline operators—as an everyday drafting practice tool.

Success of Kirchner's efforts and those of his Committee are evidenced by these facts:

1. Over 2000 copies of the Manual already have been distributed.

O. E. Kirchner

Chairman, SAE Aeronautical Drafting Manual Committee

2. The Manual is widely accepted in industry as standard practice. In fact, the Aircraft Engine Division, Packard Motor Car Co., is one of a number of companies that have adopted it as the company drafting standard. Special company requirements are added in supplements to the Manual.

3. The Manual is working its way into aeronautical engineering class rooms as a text book in aeronautical drafting.

4. The Manual has been instrumental in promoting decimal dimensioning instead of the fractional system in the aeronautic industry. Chairman Kirchner reported recently that 48 companies in the aeronautic field now are using decimal dimensioning.

The revised Manual or the revisions alone are now available from the SAE Aeronautics Department. Prices: complete Manual, $3.00; revision kit, $1.25; additional cost for Manual leatherette loose-leaf cover is $2.00.

# Hunt in Holland for SAE On International Standards

J. H. HUNT, General Motors Corp., sailed early last month for The Hague, Holland, to participate as an American representative designated by the SAE in a meeting of the Committee on Automobiles, of the International Standards Organization. The meeting was held Oct. 18-23.

J. H. Hunt

Major topics on the Committee's agenda discussed were: (1) motor vehicle lighting, (2) dimensional standards, primarily concerning electrical equipment, and (3) brake regulations.

Biggest difference between American and European vehicle lighting practice is in headlighting. General European tendency is to provide more intense illumination down the center of the road on the upper beam; seeing is sacrificed on the lower beam in the interest of minimizing glare.

American headlights provide less intense illumination down the center of the road because of the 75,000-candlepower legal limitation. And American headlighting engineers tend toward the high side of glare limits on the lower beam to improve seeing.

One of the important dimensional standards under consideration was spark plug threads.

Hunt was chosen by the SAE Technical Board to extend the American viewpoint on these matters because of his suitability for the job. As Secretary of the Engineering Liaison Committee, of the Automobile Manufacturers Association, he has kept abreast of both lighting developments and brake regulatory matters in this country.

# SAE Helicopter Group Ponders Friction Wear

PROBING of molecular eccentricities —which cause deteriorations of bearings and surfaces in contact—by the SAE Helicopter Committee resulted in several recommendations to alleviate the trouble.

To cope with friction oxidation, the phenomenon of failure in oscillating bearings, the group proposes a specification for a grease to help cure the ill. A survey of fretting corrosion—the related breakdown of a surface in contact under high pressure and little relative motion—is recommended for further laboratory study.

Engineers define friction oxidation as the ordinary type of failure for bearing races in reversing applications; there is a simultaneous oxidation of the grease (which becomes acid) and oxidation of race metal. A considerable volume of metal is thus removed from the race under ball contact, causing oxidized iron (rouge) to mix with the grease and form a lapping compound, which speeds up deterioration.

The Committee believes that a proper grease will alleviate friction oxidation. Existing military grease specifications, AN-G-15 and AN-G-25, the confreres feel do not outline all requirements for helicopter oscillating bearing greases. For this reason they have prepared a proposed specification which does meet these requirements. Included in the proposal is a friction oxidation test and a description of the test apparatus.

Circulating the proposal among helicopter, bearing, and grease manufacturers produced a majority of replies in favor of some type of friction oxidation test. After agreement has been reached within the Committee on details of the specification, it is planned to transmit the proposed specification to the military services via the Aircraft Industries Association with the recommendation that it be issued as an Air Force-Navy document.

### Fretting Corrosion

To learn more about the nature of fretting corrosion, a member of the friction oxidation family, the Committee made a survey of helicopter, bearing, and propeller manufacturers.

This type of deterioration, it is reported, occurs on surfaces under pressure—usually high—and relative motion—usually small; the surface roughens and red iron oxide is created. This action also has been labelled galling fatigue, chafing fatigue, and friction oxidation.

Engineers replying to the questionnaire say they have experienced this type of failure in clamped and shrink-fitted specimens subjected to repeated bending; riveted joint fatigue specimens subjected to repeated axial loads; large fatigue test rigs subjected to steady axial loads and repeated bending; and propeller blade retentions and hub parts. Others have observed it in riveted joints.

One respondent advised that minute motions are necessary for fretting corrosion. In faying surfaces the motion may be longitudinal as in beam action, torsional within a press fit, or compressive as in splines. Deterioration, he

says, can take two distinct paths.

At first the rust product withdraws material from critical locations on the mating surfaces. Rust products are less dense than the base metal. If a high percentage of the rust is free to escape, the joint will wear loose and the fretting cycle will speed up. If the rust product cannot escape, the joint will freeze up because the lower density rust packs into available space and eventually reduces small relative motion to zero. Trouble comes when it is necessary to break the junction for replacement of parts. It's particularly bad when inspecting assemblies at close intervals, such as for CAA inspections.

### Theory Elusive

Despite prevalence of fretting corrosion in most of the companies contacted, little is known about how or why it happens and how to prevent it. For this reason the Committee is sending all information it has accumulated on the subject to the National Advisory Committee for Aeronatics, Air Materiel Command, Navy Bureau of Aeronautics, and the National Bureau of Standards. It points out to these agencies that the following research is needed:

1. Determination of the mechanism of fretting corrosion.
2. Determination of behavior of mitigators for applications where fretting corrosion occurs.
3. Determination of practical methods to prevent it in typical applications.

## Technishorts . . . .

**VEHICLE MOBILITY:** Late last month the SAE Controlled Soil Vehicle Testing Committee participated in a vehicle mobility conference at the Aberdeen Proving Ground. The program included reports and analyses from government groups conducting research in this field. SAE Committee member J. L. Deffenbaugh, Caterpiller Tractor Co., analyzed progress of vehicle mobility research projects to date.

**HEAT-TREAT TERMS:** Definitions of heat-treating terms, now in the SAE Handbook, have been brought up-to-date by a joint SAE-ASTM-American Society for Metals—American Foundrymens Society committee. The revised list, to be published in the 1949 Handbook, includes eight new heat-treating techniques. Interrupted aging, recrystallization treatment, and spray quenching are among the new processes defined.

**CHAIN SLOTS:** A recommendation covering passenger car wheel slots for attaching chains is being readied by an SAE group under C. F. Arnold, Cadillac Motor Car Division, GMC. Committee members favor four chain slots per car wheel to permit installation of emergency unit chains. Dimensions of each slot, most feel, should be about $\frac{3}{8}$-in. minimum depth and $1\frac{1}{2}$-in. minimum width. Smooth slot edges were stressed to prevent cutting of straps. Also seen desirable is locating outer edge of chain slots as close as possible to the rim's inner diameter.

**HYDRAULIC CONTROLS:** Job of standardizing hydraulic power controls is being studied by a group of the SAE Construction and Industrial Machinery Technical Committee. Committee members point out the need for the following work on hydraulic controls for earth-moving machines: classification of hydraulic systems; standardization of fittings, mounting flanges, and drives; recommendations for hydraulic fluids.

**BRAKE LININGS:** The newly revised SAE standard for brake linings, rivets, and bolts is expanded to include sizes and drilling patterns for riveted and bolted truck and bus brake linings. Standard for commercial vehicle sizes starts with 13-in. size. Measurements also are given for brake blocks. (Brake blocks are lining segments $\frac{1}{2}$ in. and thicker.)

# Release First Standards For Aero Utility Parts

THIRTY-SIX hex head bolt standards and seven gasket standards were just issued by SAE. They are the first fruits of industry-military agreement, reached early this year, to switch the standards making job for airplane engine and propeller utility parts from the Air Force and Navy to SAE.

This is just the beginning of a big job tackled by SAE, at the request and with cooperation of the Aircraft Industries Association. These new standards carry AN parts numbers. This effort represents a move toward industry self-control in the AN standards area.

Unlike government-produced AN standards, those issued by SAE do not use a significant numbering system. This means that the number is not coded, as in the old system, to indicate size, length, or material of the part. In the SAE nonsignificant numbering system, the AN numbers will consist of six digits, starting with 100,000. (The 43 new standards start with AN 101001.)

With the SAE numbers, every single variation in the part calls for a new number. Each standard is complete in itself. The document gives all the information on dimensions, material, and identification needed to manufacture, procure, and inspect the part. Where necessary, these new AN standards will make some reference to an SAE Aeronautical Material Specification for material, process, and manufacturing quality control. For example, the new AN bolt standards refer to AMS 7452, a manufacturing specification, to AMS 6322 for material, and to AMS 2640, an inspection specification.

### Narrower Tolerances

Another characteristic of these SAE-produced AN standards, is that they are constant quality standards. This means that requirements on materials, dimensions, and finishes are lots tighter than they were with government-issued AN standards. Incidentally, the unsatisfactory experience of engine and propeller manufacturers during the war with utility parts purchased to AN standards had much to do with the changeover to industry-made AN standards. Wide variations, sometimes permitted in material, dimensional tolerances, or tensile strength, often left the engine or propeller builder unsure of the part's serviceability for a particular use.

The new standards are available from SAE. Copies have been sent to AIA, who will distribute them to the Aeronautical Standards Group (WCAB), and also reprint them for all interested government offices and personnel.

Members of the SAE Engine and Propeller Utility Parts Committee, which is preparing these standards, are: J. D. Clark, chairman, Bureau ofAeronautics; W. P. English, vice-chairman, Ranger Aircraft Engines; W. B. Billingham, Hamilton Standard Propellers; W. F. Burrows, Aircooled Motors Corp.; G. N. Cole, Pratt & Whitney Aircraft; H. W. Epler, AVCO Manufacturing Corp.; G. M. Garcina, Allison Division—GMC; A. E. Gibson, Packard Motor Car Co.; W. D. Hazlett, Aeroproducts Division—GMC; R. L. Keene, General Electric Co.; M. E. Mills, Wright Aeronautical Corp.; Virgil Newman, Aid Materiel Command; F. H. Norriss, Westinghouse Electric Corp.; and J. B. Reese, Curtiss-Wright Corp.

# About

**JOHN P. GATY,** vice-president and general manager of the Beech Aircraft Corp. in Wichita, Kans., was elected to the board of directors of this company at a board meeting held on Sept. 14 in Wichita.

**C. B. SEYMOUR** has announced his association with Kepner Products Co. in Summit, Ill. He will serve as vice-president of this company, who produce precision machine parts and assemblies. Seymour was formerly connected with Hoof Products Co. in Chicago. He is chairman of the SAE Chicago Section Reception Committee.

**EDWARD R. BARNARD** has retired as assistant director of Research of Standard Oil Co. (Ind.) Chicago, and has entered consulting engineering at Clearwater, Fla. He served as the 1943 Chairman of the Chicago Section following many years of active participation in that group's administration.

**RALPH S. WILSON** has joined the Technical Data Division of Wright Aeronautical Corp., Wood-Ridge, N. J. He had been assistant supervising engineer of the Lycoming Division, Avco Corp., Williamsport, Penna., where he was chairman of the SAE Williamsport Group reception committee and later secretary.

**HUMPHREY F. PARKER** has been appointed director of research and development for Columbus McKinnon Chain Corp., Tonawanda, N. Y., having served the company as chief engineer. He was 1944–45 chairman of the SAE Buffalo Section reception committee. He will also head development work for Chisholm Moore Hoist Corp., a subsidiary.

**JOSEPH MARRETT CURTIS** is now foreman—assembly, C. G. Wood Co. in Girard, Pa.

**JOHN M. CAMPBELL,** and **LLOYD L. WITHROW,** General Motors Research Division, General Motors Corp., told the American Chemical Society, Sept. 7 in St. Louis, that chemical engineers have "an outstanding opportunity to serve the national interest" and save money for motorists by boosting gasoline efficiency. Nearly 2,400,000 bbl of gasoline are used daily, they pointed out, and a 1% gain in fuel economy would represent savings from 1 to 2 millon gal daily.

**PAUL G. HOFFMAN,** administrator of the Economic Cooperation Administration was a recipient of the New York Board of Trade award and spoke at the Business Speaks dinner Oct. 14.

**KARL SIEGLE** has joined Continental Aviation & Engineering Corp., Detroit.

**EDWIN D. SCOTT,** former supervisor of body engineering at Ford Motor Co. has joined the engineering staff of Paramount Engineering Co., Detroit, as executive engineer.

**JAMES L. SMITH** recently graduated from the University of Oklahoma in Norman, Okla. He is now a mechanical inspector at the Continental Oil Co. in Ponca City, Okla.

**HERBERT C. NOLL,** formerly with Autocar Co., Los Angeles, has been named service manager and shop foreman of H-R Truck & Equipment Co., in that city.

**CLAYTON A. LEWIS** has joined the aircraft overhaul staff of American Airlines, Inc., at Tulsa. He is a recent graduate of Parks College of Aeronautical Technology, East St. Louis, Ill.

**B. H. HASSELBING** has been named powerplant engineer of Jones & Laughlin Supply Co., Engineering & Construction Division, Tulsa, Oklahoma. He had been president of Engineering & Development Co., Lake Charles, La. He hopes to succeed in designing an airplane with helicopter or vertical landing characteristics as a hobby.

**DR. GUIDO SORIA** has moved his consulting engineering office to 250 West 57 Street, New York 19, N. Y.

**FRED W. TREBES,** formerly chief engineer of Karl Douglas Co., has been appointed aircraft powerplant design engineer of Northrop Aircraft, Inc., Hawthorne, Calif.

**IRWIN LOUIS MARKOWITZ,** a graduate of California Institute of Technology, has become a junior engineer with Johnson Pump Co., Los Angles, builders of deepwell turbine pumps.

**ARTHUR F. SIMPSON** has become president and general partner of both Shannon & Simpson Mfg. Co., parts manufacturers, and California Exploration Co., oil well producers, Alhambra, Calif. He had been vice-president of Davenport Mfg. Co., Los Angeles.

**RICHARD L. WUNDERLICH** joined the H & S Modern Baking Co., Sandusky, Ohio, as a management trainee upon graduation from Purdue University.

**JOSEPH GESCHELIN,** a past vice-president of SAE, and Detroit editor of Chilton publications, will address the Cleveland Dotted Line Club, Nov. 8 on design features of passenger cars and probable trends.

LEAR

MOCK

**WILLIAM P. LEAR,** president of Lear, Inc. since the inception of the company almost 20 years ago, was elected to the newly created post of chairman of the board and **RICHARD M. MOCK** was elected president. Lear is also director of research and development. Mock, who has been executive vice-president since 1947, has been carrying the duties of president for some time to free Lear to devote his time and energies to technical development of aircraft radio, automatic flight control and wire recorder devices

# Members

**RICHARD U. SKARSHAUG,** now chief of industrial therapy for the Veterans Hospital in American Lake, Wash., had been training officer for the Veterans Administration at Washington State College, Pullman, Wash. At his new post, Skarshaug trains and retrains disabled veterans in vocational fields—chiefly auto mechanics. Upon release from the hospital the veterans are placed in their respective fields through the State of Washington.

**GORDON D. BROWN** has reentered the consulting field with his own company—Gordon D. Brown & Associates, 634 S. Spring St., Los Angeles. Their work is that of management consultants with emphasis on financial planning. He had been vice-president of Bankers Trust Co., New York City.

**FREDERICK C. CRAWFORD,** president, Thompson Products, Inc., has received for his company the "Financial World" trophy for the best 1948 Annual Report produced in the automotive equipment industry. Presentation was made at an Annual Awards Banquet at the Hotel Pennsylvania in New York on Oct. 21.

**WILLIAM B. JEROW,** who had been lubricants engineer with Shell Oil Co., Inc., Grand Rapids, Mich., is now staff engineer with this company in New York City.

**EDWIN N. LAURANCE** has become assistant superintendent of detail manufacturing for the Glenn L. Martin Co. in Baltimore, Md. He had been factory manager for Bellanca Aircraft Corp., New Castle, Del.

**ULYSSES A. PATCHETT** is a lecturer in mechanical engineering at the University of California, Berkeley, Calif. His former post was supervisor of experimental assembly and test for Jack & Heintz Precision Industries, Inc., Cleveland. In the past, Patchett has been treasurer, vice-chairman and chairman of the SAE Northern California Section.

**RICHARD BRUCE JOHNSON** is application engineer at Vickers, Inc., Detroit, after having been with the Holley Carburetor Co., same city.

**FRANCIS E. ELWOOD,** who recently graduated from Purdue University, West Lafayette, Ind., has become assistant plant engineer for the Best Foods, Inc. in Bayonne, N. J.

**WALTER L. CARVER** has been given the Justin P. Allman Award by the National Wall Paper Wholesalers' Association "for his leadership in the application of engineering viewpoints and methods to manufacturing, merchandising, and distribution in the wall paper industry." Now managing director of the Wall Paper Institute, Carver was for many years an engineering executive in the tractor and automobile fields and in the early 30's represented General Motors' Overseas division on a special assignment in Russia.

**WILLIAM H. WILSON** has been appointed sales engineer for the Aluminum Co. of America, Baltimore, Md. Prior to this he had been development engineer for this company in Cleveland. Wilson was plant representative for the SAE Cleveland Section in 1946 and 1947.

**AMONG SAE MEMBERS affected by recent realignments in executive duties at General Motors Corp. are:**

**O. E. HUNT,** executive vice-president, who now has under his direction three operating divisions: Engine; Dayton and Household Appliance; Overseas and Canadian. **L. C. GOAD,** vice-president, who becomes executive in charge of the Body and Assembly Divisions Group—reporting to executive vice-president M. E. Coyle. Goad will be SAE vice-president representing Production Activity for 1949. **THOMAS P. ARCHER,** vice-president, who goes on a disability leave of absence. Goad succeeds him. **RODGER J. EMMERT,** formerly factory manager of GMC Truck & Coach Division, who now heads a Facilities and Processing staff . . . and **ROGER N. KYES,** newcomer to General Motors, who heads a Procurement and Schedules staff—both a part of the General Staff which reports to newly-elected Executive Vice-President H. H. Curtice. **JOHN E. JOHNSON** becomes general truck sales manager and **JOSEPH P. LITTLE** goes to the general manager's staff at the GMC Truck & Coach Division.

HUNT

GOAD

ARCHER

LITTLE

JOHNSON

KYES

EMMERT

**S. R. ZIMMERMAN, JR.**, has been named director of Friction Material Research and Development for Raybestos-Manhattan, Inc. He will direct the corporation's research and development activities on its friction materials at its plants in Stratford, Conn., Manheim, Pa., Passaic, N. J. and North Charleston, S. C.

**R. R. "RAY" FALLER**, manager of Employee Relations, Ethyl Corp. Research Laboratories, Detroit, has been promoted to the position of head of the Executive Training Program for the entire Ethyl Corp. He will make his headquarters in New York City. Faller was a member of the SAE Detroit Section Governing Board during 1947-48.

**WALLACE F. ARDUSSI**, sales and engineering executive, has purchased the Variety Machine & Stamping Co. in Cleveland, Ohio. The company has been operating as a high production manufacturer of metal stampings, assemblies, and tools and dies, for the past 27 years.

**CARL E. SCHMITZ**, vice-president and director of engineering, Crane Packing Co., Chicago, has been appointed a member of the Annual Awards Committee of the American Society of Lubrication Engineers. This Committee annually awards the Alfred E. Hunt Memorial Medal, affords two persons honorary life membership awards in the American Society of Lubrication Engineers and presents an annual Junior award.

**JOHN WEBER** has been appointed president of Truck Cab Mfg., Inc. in Cincinnati, Ohio. He had been associated with the Trailmobile Co., same city.

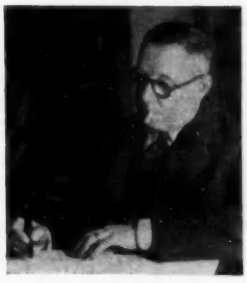
**RUDOLPH F. RIESZ** has become manager and majority owner of AVC, Inc. in Skyforest, Calif. He was previously service engineer of the Ryan Aeronautical Co., San Diego and was plant representative for the SAE San Diego Section in 1947.

**GEORGE P. FENN**, no longer connected with the Witte Engine Works Division, Oil Well Supply Co. in Kansas City, Mo., is assistant manager of the Sales Development Division at Caterpiller Tractor Co. in Peoria, Ill.

**ROBERT W. SUTTON**, carburetor development engineer for the Eclipse Machine Division of Bendix Aviation Corp., Elmira, N. Y., had been affiliated with Bendix Products Division in South Bend, Ind.

**JAMES M. REYNOLDS** is motor equipment engineer for the Michigan Bell Telephone Co., Detroit, after graduating from Michigan State College, in East Lansing.

**C. E. WILSON**, president of General Motors was the dinner speaker at the annual meeting of the Automotive & Aviation Parts Manufacturers association on Nov. 4. The meeting was held at the Statler Hotel, Detroit.



**WILLIAM C. STODDART** was recently appointed editor-in-chief of "Motor Commerce and Industry", the trade journal published by Motor Commerce, Ltd. in London, England. He was formerly joint editor.

**ABRAHAM SCHNAPF**, who recently graduated from the School of Technology at the College of the City of New York, New York City, is now mechanical engineer, junior designer at Goodyear Aircraft Corp. in Akron, Ohio.

**GEORGE G. YOUNGER** has become an aeronautical engineer at the National Advisory Committee for Aeronautics in Cleveland, Ohio.

**HARVEY S. FIRESTONE, JR.**, chairman and chief executive of the Firestone Tire & Rubber Co., was the principal speaker at the American Trucking Association's convention meeting on Oct. 10 in Washington D. C. "Truck Transportation and the American Way," was his subject.

**ROGERS G. MUNN** is now research planner at the Aerojet Engineering Corp. in Azusa, Calif. Prior to this he was shop superintendent for Chas. D. Stromgren Co., Los Angeles.

**O. H. LOVELACE**, formerly sales engineer for Willys Overland Motors, Inc., Toledo, Ohio, recently became associated with the Dearborn Motors Corp. in Detroit.

**WILLIAM HAMILTON, JR.** was recently appointed chief engineer at the Noma Electric Corp. in New York City. He had been plant manager of the Bubble-Lite Division of Noma, and prior to that was manager of Plant #2 for the Watson Flagg Machine Co. in Paterson, N. J.

**RAYMOND T. LONG** is now president of Raymond T. Long Co. in Towson, Md. His duties as president will mainly be confined to the analysis of delivery and maintenance cost for their clients and recommending ways and means to reduce cost and increase efficiencies in delivery operations.

**WILLARD L. KLINGMAN** is now project engineer, Fuel Cell Division of the Firestone Tire & Rubber Co. of California in Los Angeles.

**ADRIAN HUGHES** has been appointed chief engineer in charge of all engineering—Power, Way and Structures, Shops and Equipment, for the Baltimore Transit Co. in Baltimore, Md.

**WALTER A. ALASKA**, prior to becoming laboratory technician for the Parker Appliance Co. in Cleveland, Ohio, was instrument specifications writer for Arthur G. McKee & Co.

**NEIL A. MOORE**, previously affiliated with the Sealed Power Corp. in Muskegon, Mich., has been appointed director of Federal-Mogul Service for the Federal-Mogul Corp. in Detroit.

**L. B. McGONAGILL, JR.** has become airplane and engine mechanic at Tennessee Air National Guard, Municipal Airport, Memphis, Tenn.

## SAE Members Said . . . . .

"The automotive diesel engine evolved into a hybrid type, combining the best features of the diesel and the gasoline engine. Later developments produced a true diesel automotive engine with increased power output and a reduced weight and cost per horsepower. It obtains two tonmiles of transportation from fuel which yielded only one tonmile before." **P. E. BIGGAR**, executive engineer, GM Truck & Coach Division, Diesel Engineering Symposium, Cornell University, Sept. 4.

**R. DIXON SPEAS**, in his new book Airline Operations, summarizes the many operating factors bearing upon satisfaction of customers and stockholders in an airline's operation. It describes and illustrates airline organization, flight and ground equipment, procedures, services, and economics. As assistant to the vice-president of engineering of American Airlines, Inc., he has had ample insight into his subject, and has handled it with conspicuous clarity. Publisher is American Aviation Publications, Washington, D. C. Speas is a past-chairman of Metropolitan Section.

**T. N. BUSCH**, secretary-treasurer of Frontier Leather & Metal Craft Corp., Amarillo, Texas, has organized the Investment Development Co. in that city to select new products for promotion.

**WILLIAM LITTLEWOOD**, vice-president in charge of engineering of American Airlines, Inc. has been elected to the board of directors of the Cornell Aeronautical Laboratory. A past vice-president of the Society, he won the Wright Brothers Award in 1935 for "outstanding contributions to aviation," is the author of numerous technical papers, and a past vice-president of the Institute of the Aeronautical Sciences. He graduated from Cornell University in the class of 1920.

**S. R. KENT** has resigned his duties as assistant sales manager of Bendix Aviation Corporation's Scintilla Magneto Division, and has assumed the position of director of advertising for American Aviation Publications in Washington, D. C.

**RICHARD E. HISS**, now design engineer for Airesearch Mfg. Co. in Los Angeles, was formerly project engineer for Continental Aviation & Engineering Corp. in Detroit.

**M. A. MAURER** is now parts quality supervisor for RCA Victor, Engineering Products Department at Camden, N. J.

**DR. J. S. REID**, one of the founders of Standard Products Co., Cleveland, and inventor and developer of many of its products and machines, became chairman of the board of Standard Products following the recent annual meeting of the board of directors. In his new capacity, Reid will devote practically his entire time to product development and research—a phase of the business which has always been his chief interest.

**A. N. LAWRENCE**, sales manager of the Aviation Division of Jack & Heintz Precision Industries, Inc., Cleveland, announced the opening of their new branch office in Los Angeles. He also announced the appointment of **P. R. BAUS** as manager of this branch office which will be located at 409 Hollywood Professional Building, 7046 Hollywood Boulevard, Hollywood 28, Calif.

**W. D. ELLISON**, manager of aviation sales for General Petroleum Corp., has been appointed engine builders' field representative for Socony-Vacuum Oil Co., in the Southern California area. He joined General Petroleum in 1930 and specialized in lubrication engineering prior to becoming head of the aviation department in 1942.

**J. BARRAJA-FRAUENFELDER**, since his retirement from the American Locomotive Co. as consulting engineer, is now a free lance consultant on diesel engine design and development, including supercharging two-cycle engines, free piston engines and allied problems.

**PETER V. DUNN** is now designer and draftsman for the Electro-Mechanical Construction Co. Ltd. in Johannesburg, South Africa.

**H. F. BROWN**, formerly vice-president of Boeing Airplane Co., Seattle, has been appointed factory manager of the Airplane Division, Curtiss-Wright Corp., Columbus, Ohio.

**WILLIAM C. REID**, consultant to the American Metallizing Contractors Association, St. Louis, Mo. will represent that organization on an inspection tour of metallizing operations in England. He left for England on Sept. 30. The results of his trip will be reported to the membership of AMCA at their next meeting in Tulsa on Dec. 2, 3, and 4.

**JAMES FREDERICK SULLIVAN, JR.**, who had been an instructor and graduate student at the University of Minnesota in Minneapolis, was recently made sales development engineer for the Aluminum Co. of America in New Kensington, Pa.

**JOHN H. SAMS**, recently graduated from Oklahoma A & M College, Stillwater, Okla., has become a diesel engineer with the Halliburton Oil Well Cementing Co. in Ventura, Calif.

**EARL C. GINN** has been elected executive vice-president and director of engineering, Continental Motors Corp., Muskegon, and has been succeeded as chief engineer by **G. WAINE THOMAS**, formerly assistant engineer of the Transportation-Agricultural-Industrial Division. **ANDREW H. BOERGER** is assistant chief in charge of design, and **WILLIAM A. ENGSTROM** is assistant chief in charge of development, **THOMAS J. REEVES** is development engineer and **EDWARD WICKLAND** is assistant development engineer. **WILLIAM WISEMAN** is assistant chief engineer and manager of quality control. Ginn, Thomas, and Engstrom are past chairmen of the Western Michigan Section, Reeves is program chairman, and Wiseman is vice-chairman.

**JOHN M. HILDT, JR.**, no longer project director of Illustrated Technical Products in New York City, has become technical editor for Cushing & Nevell in New York City.

**J. WILLARD LORD**, safety engineer of the Atlantic Refining Co. has been elected chairman of the National Advisory Committee for Motor Vehicle Fleet Supervisor Training, following a meeting of the committee at The Pennsylvania State College.

**THEODORE P. WRIGHT**, Cornell Aeronautical Laboratory and **CHARLES H. COLVIN** are trustees of the Aviation Research Institute, publishers of the new 544-page World Aviation Annual of 1948.

**JOHN EDWARD WHATMOUGH** is now scientific officer, tracked vehicles, at the British Ministry of Supply, Chertsey, Surrey, England. He had been chief engineer with Nicholas Straussler & Co., Ltd., London.

## OBITUARIES

### GEORGE C. WARNER

George C. Warner, who was sales engineer for the Marlin-Rockwell Corp. in Detroit, passed away in that city on Sept. 28.

He was 65 and had lived in Detroit for 23 years. Warner had been a member of the SAE since 1920.

### ALLEN RAE

Allen Rae, Toronto branch manager of A. Schrader's Son, Division, Scovill Mfg. Co., passed away on August 28.

Prior to joining the Schrader Canadian organization in 1935, he was associated with the Dunlop Tire & Rubber Goods Co., Ltd., for 13 years.

Rae became a member of the SAE in 1940.

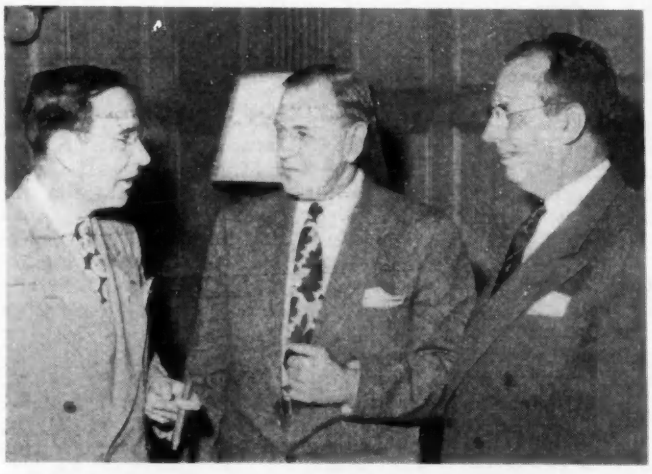
# AIRCRAFT ENGINEERS Vision

## Panels discuss requirements, airframe, equipment, and powerplants at National Aeronautic Meeting, in Los Angeles

THE overseas transport of 1955 will be much like today's transports in appearance, but its safer, simpler equipment plus compounded reciprocating engines or gas turbine powerplants and new navigation and traffic-control aides will help balance the airlines' books—if the airlines can operate at good load factors. This is one picture of the imaginary transport—nicknamed the SAE 1—that grew from discussion of its design and certification at the Autumn National Aeronautic Meeting.

In contrast to this confidence in airframe design and emphasis on equipment and powerplants of a conventional-speed aircraft was the concern with aerodynamic and structural problems shown by designers of aircraft for high-speed, high-altitude flight. They defined advanced aerodynamic problems that call for further experimental and theoretical research and studied ways to sustain the sudden, tremendous loads associated with high-speed flight on both airframe and human structures.

"Most constructive ever held" was the way many described this National Aeronautic Meeting, held October 6-9 at the Hotel Biltmore, Los Angeles, California. Outstanding feature of the Meeting was the all-day panel discussion of the transport of 1955, organized by Aircraft Powerplant Meetings Chairman W. J. Blanchard. Other highlights were an all-day inspection trip to Muroc Lake Air Base, presentation of the Manly Memorial Medal to E. F. Pierce and H. W. Welsh, presentation of the Daniel Guggenheim Medal to Leroy R. Grumman, and a concluding banquet and ball.



General Chairman L. D. Bonham of the 1948 SAE National Aeronautic Meeting & Aircraft Engineering Display, left, with SAE President R. J. S. Pigott and W. J. Blanchard, Aircraft Powerplant Meetings Chairman and originator of the "Plane of 1955" all-day panel

Enthusiasm and active member-participation marked every session of this outstanding gathering, in operation of which the Aircraft Industries Association of America and the Air Transport Association of America cooperated with SAE and its eight West Coast Sections and Groups. Total attendance topped 900, while individual session attendance hit an all-time high. One session went over 600.

Over 200 made the special SAE-members-only visit to the AAF Base at Lake Muroc, Calif. to inspect the Army's latest experimental designs of rocket and jet fighters and bombers. The new craft were spread out for static inspection and many were also displayed in flight. The SAE group was welcomed in brief talks by Commanding Officer Col. S. A. Gilkey and by Maj-Gen. F. O. Carroll, chief of engineering division, Air Materiel Command, Wright-Patterson Air Force Base.

Although the program of the panel discussion on the long-range overseas transport of 1955 specified the plane was to carry 50-100 passengers at a cruising speed of 400 mph for a range of 3500 miles, one airlines engineer showed that economic and performance considerations at a 60-65% break-even load factor toned the specifications down to 48 passengers and 330-360 mph at 30,000 ft for the same range. He counted on 12,000-lb payload, 6000-gal fuel capacity, and 7000-ft long take-off and landing fields.

Not everyone agreed with this revision of specifications. One man produced figures to show that switching to larger airplanes has generated business, that in a case where the 21-passenger DC-3 averaged about a 60% load factor of 12 people, the 40-passenger Convair also averages a 60% load factor, which is 24 passengers, or twice the number with the DC-3. Others criticized the airlines for allowing themselves as high a break-even load factor as 60-65%, adding that indirect costs should be

# 1955 TRANSPORT

"Plane of 1955" panel experts were chosen from the nation's leading aeronautical engineers. The panels proved to be the most dramatic feature of the meeting

POWERPLANTS & EQUIPMENT Panel, top: Warren Boughton, Phaostron Co.; R. E. Johnson, Wright Aeronautical Corp.; Panel Chairman A. T. Colwell, Thompson Products, Inc.; L. H. Enos, Curtiss Propeller Division; Ray D. Kelly, United Air Lines, Inc., and W. J. Blanchard, general chairman of the all-day session whose keen concept and brilliant execution made this an outstanding technical event

REQUIREMENTS Panel, center: D. O. Benson, Northwest Airlines, Inc.; W. W. Davies, United Air Lines, Inc.; Chairman William Littlewood, American Airlines, Inc.; Charles Froesch, Eastern Air Lines, Inc. and L. R. Koepnick, Trans World Airline

COMPLETE DESIGN Panel, bottom: Harold Adams, Douglas Aircraft Co., Inc.; A. J. Fokker, Consolidated Vultee Aircraft Corp.; Panel Chairman D. R. Shoults, Glenn L. Martin Co.; H. D. Hoekstra, CAA, and C. L. Johnson, Lockheed Aircraft Co. George Tharratt, Douglas Aircraft Co., Inc., presented a visual representation supplementing the panel program

brought down to direct costs and break-even load factors to 50%. Still others wanted to keep the 400-mph specification because they feel the higher speed may be more economical in seven years. One went so far as to stipulate 550 mph at 37,500 ft.

Airframe experts reported they expect no new aerodynamic or structural problems with the 400-mph-or-slower transport that will result in radical appearance. They did foresee thin wings suspending engine nacelles for four engines. Suspended nacelles are more accessible and give ideal intake and outlet conditions. Because suspended nacelles do not interfere with flaps, they cut drag and wing area slightly. Drag of the nacelle can be cut almost to the level of skin friction alone if interference drag is avoided.

Discussers agreed that the powerplants should be housed so that undetected, or detected but uncontrolled fires can be allowed to burn freely to the extent of complete loss of powerplant with no damage to primary wing, fuselage, or landing gear.

The conventional wing planform will be used, but wing loading will be low and maximum wing thickness may be only 12%, if turbojets are used—too thin to accommodate passengers—it was prophesied.

There was general agreement that the landing gear belong in the fuselage, where the pilot can detect fire in this high-rubber-concentration com-

J. W. Sinclair, chairman of the Southern California Section, left; D. S. Sanborn, chairman of the San Diego Section; SAE Vice-President A. L. Klein, Aircraft; W. C. Lawrence, Air Transport Meetings chairman; SAE Vice-President W. W. Davies, Air Transport, and H. D. Hoekstra, Aircraft Meetings chairman

ponent promptly.

Every bit as important as the airframe of the transport of 1955 will be its operating systems and equipment, operators insisted, reminding designers that more than half of all mechanical difficulties are due to these items.

The airlines want safe, simple systems that will be easy to maintain and operate. To ensure it, they urged airplane manufacturers to let systems engineers in on the design during its preliminary stages . . . allot adequate space to wiring, ducts, and tubing . . . segregate systems . . . install no unnecessary systems . . . plan for manual control and operation unless there is unquestionable justification for automaticity.

It appeared likely that the 1955 transport will have an a-c electrical system to supply part or all of the auxiliary power demands supplied by d-c systems in today's aircraft. One discusser predicted 120-v d-c and 400-cycle 208-v a-c systems. Another discusser proposed 28-v d-c plus 115-or-higher-v unregulated frequency a-c systems. He felt that the present 28-v d-c system should be retained to power many time-proved items of d-c equipment that the customer will favor because he uses them on other airplanes. But, he said, a-c systems at voltages higher than 28 will save weight where large quantities of power are needed as for lighting and heating loads of anti-icing and cooking equipment. A third discusser proposed that all auxiliary power be primarily a-c electrical power.

Simplicity in producing the electrical power was interpreted in different ways. Some people favored driving the generators and alternators off the main propulsion powerplants instead of auxiliary units. Others felt that the 200-300-hp auxiliary power load would be too great a drain on the propulsion units but preferred dual auxiliary powerplants to separate power sources for each piece of power-consuming equipment. Small gas turbine powerplants were envisioned for auxiliary powerplants, perhaps designed with excess compressor capacity to pressurize the cabin. Otherwise, if the main propulsion units are turbines, it may be easier to bleed off their compressors for cabin supercharging than to install separate cabin superchargers.

Where auxiliary power needs can not be supplied by electricity, pneumatic systems are generally preferred to hydraulic systems. Reasons are that energy for pneumatic systems can be built up gradually in pressure reservoirs to supply short-time high demands and that leakage isn't a fire hazard and doesn't saturate insulation or baggage.

### Simplicity Stressed

In the matter of cockpit equipment, airline men stressed that simplicity contributes to safety. One cockpit expert granted that primary controls with attachments and gadgets make for ease of basic control, but he said they are not worthwhile in the long run. The extras malfunction and are too difficult to maintain.

The concern of the airlines with equipment and systems will probably be reflected soon in intensive CAA study of these items, it was predicted. Likely changes in the C.A.R. will be toward improved equipment reliability and greater operational simplicity as well as greater fire safety, according to one observer. Although he believes present Regulations sufficiently objective to permit unhampered development of the 1955 transport, he expects revisions in the C.A.R. will give even greater objectivity and more delegation of authority and responsibility.

Propulsive power for the 1955 transport will be furnished by compounded reciprocating engines, turboprops, or turbojets—the authorities couldn't agree which.

Besides low fuel consumption, most convincing argument for reciprocating engines was time. A powerplant engineer traced the design timetable for the transport backwards to show that if the airplane is to be ready for commercial passengers on January 1, 1955, its powerplant must be selected and financial arrangements made for its development

by January 1, 1949, only two months from now. He felt that the turbojet would not be available for the 1955 400-mph airplane with low enough fuel consumption to meet the range requirements. Although his study indicated that a turboprop to do the job could be available, he felt fuel reserve requirements might be a decisive disadvantage. He pointed out that fuel consumption would soar if weather forced the airplane to seek low altitude and even at design altitude fuel reserve would have to be large to provide for holding at destination.

Results of another study, based on payload considerations only, showed that reciprocating engines give maximum range with cruising speeds below 350 mph, that turbojets are best above 500 mph, and that turboprops excell in the intermediate speed range.

If either compounded reciprocating engines or turboprops are chosen, there will be propellers suitable performancewise and stresswise, a propeller expert stated emphatically. Propeller efficiencies will be about 85% at cruise. He reported that single-rotation 4-blade propellers look best for single-compounded reciprocating engines while dual-rotation propellers promise more for double-compounded engines and turboprops.

Those who backed turbojets—and they gained many converts—reasoned that overhaul costs will be cheaper, vibration less, and drag low enough to compensate at least in part for high fuel consumption. One discusser predicted that airlines will not put up with the complexity, noise, weight, and roughness of propellers on equipment they will be using until 1960 or 1965.

Discussion from the floor brought out an estimate that turbojet fuel consumption will be cut 25% in the next five years through use of variable-area nozzles and a report that turbojets require fewer man-hours maintenance than reciprocating engines do.

### Afterburning Advocated

If the panel's turbojet advocates win their case, they will have the benefit of detailed information on application of turbojets to transports brought out at a preceding session. It was explained that since turbojets are primarily high-speed, high-altitude powerplants, fuselages must be designed for 50% greater ambient-to-cabin pressure differentials than present planes. Fuel supply will be a major problem in turbojet planes. To carry the fuel, turbojet airplanes for domestic operations will have to be in the 80,000 to 120,000-lb class.

Raising this weight off the ground will require some form of thrust augmentation, engine experts expect, because turbojet take-off thrust falls off markedly with decrease in airport ambient pressure or increase in temperature. It is considered likely that augmentation will be in the form of afterburning: the addition of energy to gases discharging from the turbine by burning fuel and excess oxygen of the gases in a suitable combustion chamber.

Present afterburners were criticized for the complexity of the transverse burner structure and the added drag of 5-7% when the afterburner is not in operation.

Although some engineers favored increasing turbojet efficiency by burning more of the oxygen in the primary burner, assuming materials to resist the higher temperatures would be available, another engineer replied that it would never be possible to burn all the oxygen in the primary burner and afterburning would always permit improvement.

One development which may alleviate the fuel reserve problem of the turbojet by enabling it to fly at design altitude in any weather and by ending airport holding is a complete all-weather navigation and landing system.

Leroy R. Grumman, left, chairman of Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y., receiving from Grover Loening, his former employer, the Daniel Guggenheim Medal for "outstanding achievement in successfully advancing aircraft design both for Naval and peacetime use." The award is jointly sponsored by the American Society of Mechanical Engineers which was represented by J. Calvin Brown, ASME regional vice-president; Institute of the Aeronautical Sciences, represented by John K. Northrop, president; and the SAE which was represented by President Pigott

Good news for all aviation was the elaborate system outlined in a report on plans of Special Committee 31 of the Radio Technical Committee for Aeronautics. The $1,100,000,000, 15-year plan calls for a Transition Program to be operating within five years which will relieve present congestion and increase schedule reliability, although it will not provide complete all-weather flying.

The Ultimate Program should be in operation by the mid-1960's to cradle civilian and military aircraft from take-off to landing. Much of the equipment to carry out the Ultimate Program remains to be devised. But the requirements have been outlined in the RTCA report, and the general principles on which the equipment will operate are known.

Although the panel discussions assumed that the transport of 1955 would be a land plane, a military man put in a good word for the flying boat at another session. For national security, they must be included in our transport fleet, he said, because flying boats match land planes in overall logistic effi-

Erold F. Pierce, center and H. W. Welsh, right, Wright Aeronautical engineers being awarded the Manly Memorial Medal by W. J. Blanchard on behalf of that Board of Award

ciency and excel where land fields do not exist. To show that flying boats need not be a commercial liability, he reminded his listeners that the larger the land plane, the larger and more costly the airport, but that nature provides seadromes. Besides, use of land-plane wing and power loadings is being considered, a move which would improve overall economy.

A session on problems of certification turned up plenty of ideas on how to speed approval that can be applied to either land planes or seaplanes: Discuss layouts with CAA representatives as soon as possible. Mock up critical parts as well as the entire powerplant installation. Put decisions in writing and secure CAA confirmation. Present whole systems and specific problems for consideration. Make use of the Designated Engineering Representative system.

More time and money will have to be allotted to testing radio, radar, and the autopilot because of the tie-in with the automatic navigation and landing systems, one speaker predicted. However, another suggested that CAA might forgo some of the complicated tests if manufacturers can assure the functional reliability of such systems in their detail designs.

Another certification authority told of an investigation made on a C-54 to see if with instrument approaches and blind landings any additional requirements should be made to ensure good stability and control characteristics. He reported that tests indicated an airplane which satisfied present requirements for stability and control would be satisfactory for instrument landings.

Designers of aircraft structures were reminded that while the C.A.R. structural requirements have been tightened, use of rational methods of structural analysis has eliminated the hidden margins of safety once built in by the old methods of analysis. Designers were warned, too, that buffeting may be a more important factor to consider in designing structures if airplanes are to fly at 30,000 ft.

When gas turbine powerplants furnish power, they may simplify certification of the heating system because heat can be derived from a tail pipe muff. Then certification testing will concentrate on proving that no carbon monoxide can enter the cabin if the muff fails.

All this engineering effort expended on design and certificating should provide the more efficient transports which—operated at good load factors—are just what the airlines need to balance their books, according to an economist's examination of cost data. Yet present competition is so great that airlines can not operate at the load factors that would allow them to buy the money-saving equipment, he said.

Duplication has divided up the revenue on some routes into such small slices that no airline gets enough to meet costs.

It was his opinion that the way out of the airlines' present financial difficulties is for C.A.B. to stop certificating more competition and to take legal action against the uncertificated carriers now giving scheduled service in violation of regulations.

Airplanes that fly very fast and very high involve a host of new aerodynamic and structural problems plus all the old ones associated with landing and low-speed flight, speakers remarked. One aerodynamicist reported that although high-speed aerodynamic problems are now fairly well known, their solution awaits further correlation between wind

Under the general chairmanship of **L. D. Bonham**, the following served as chairmen of the four technical sessions of the SAE National Aeronautic Meeting: **A. L. Klein, G. W. Newton, W. C. Mentzer**, and **B. J. Vierling.**

This report is based partly on discussions and 11 papers . . . "Physiological Aspects of High-Speed and High-Altitude Flying" by **Dr. W. R. Lovelace II**, Lovelace Clinic and Trans World Airline; "Aerodynamics of High-Speed Airplanes" by **K. E. Van Every**, Douglas Aircraft Co., Inc.; "Structural Aspects of High-Speed Airplanes" by **F. B. Sandgren**, Bell Aircraft Co.; "Problems in the Application of Turbojet Engines in Air Transports" by **Dimitrius Gerdan**, Allison Division, General Motors Corp.; "The Next Step—Afterburning" by **D. J. Jordan**, Chance-Vought Aircraft Division, United Aircraft Corp.; "Effect of the RTCA Program in Obtaining Regularity in Air Operations" by **D. W. Rentzel** and **F. B. Lee, CAA**; "Some Economic Problems of the Air Transportation Industry" by **W. L. McMillen**, American Airlines, Inc.; "Economical Aspects of Flying Boat Operations" by **Capt. C. H. Schildhauer**, USNR (Ret.); "Powerplants—Problems of Certification" by **G. W. Newton**, Boeing Aircraft Co.; "Flight Qualities and Performance—Problems of Certification" by **Melvin Gough**, NACA; and "System Functioning—Problems of Certification" by **Rudy Thoren**, Lockheed Aircraft Corp. All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

For discussion panel see page 69.

tunnel and flight tests.

Studies already completed showed that raising the effective critical Mach number is a more efficient method of increasing speed than raising engine power or decreasing parasite drag. One designer related five ways to raise effective critical Mach number: Decrease wing thickness. Decrease aspect ratio. Sweep wings backward or forward. Combine airplane components to minimize interference effects. Remove boundary layer.

Another designer asked aerodynamicists to develop more aerodynamic data on which to select a set of design load conditions for transonic aircraft. Data on pressure distribution, effects of gusts, and response of the plane to a given control are needed to obviate present conservatism in structures. No other extraordinary loads are expected, so when these three factors are understood, transonic aircraft can be designed according to maneuvering considerations, one designer reported.

Other needs of structural engineers are more knowledge of actual temperatures to be expected and a wider selection of materials. Calculations were presented to show that stagnation temperatures will reach 980 F for Mach 3 at sea level. Maybe the answer to high temperatures will be sandwiches of high-temperature resisting synthetic core between faces of stainless steel or K-monel.

As rockets replace jet engines, the problem of supplying enormous quantities of fuel will introduce the problem of designing high-pressure vessels to hold pressurizing gases. Pressures in the vessels may be as high as 5000 psi, prohibiting the weight of any but circular cylindrical shells. But the need to make optimum use of the volume within the airplane has led to tank ends ranging from flat plates to complete hemispheres. Design of high-pressure tanks is the critical aspect of fuselage design, since from other considerations, the structure will keep its present arrangement.

Human structures are being studied in relation to high-speed flight too, to measure their capabilities and ensure full utilization without undue risk, an aviation medicine specialist revealed. Human centrifuges have disclosed the restrictions made on man by application of radial acceleration: Movement in the direction of the radial acceleration is easy but hazardous. Falling 1 ft at 2 g knocks the wind out of subjects. Falls of greater distances at slightly higher acceleration will often cause injury. Even simple movements of the body at right angles to radial acceleration require much more time to perform. Subjects can not rise from a bomber seat against a force of 2 to 3 g. Above 3 g, they can not don parachutes.

The Aero Medical Laboratory has found that exposure to negative g for several seconds will lead to overdistension and rupture of vessels about the head, but exposure to higher acceleration for times under 0.3 sec does not cause much injury.

## DESIGN TRENDS IN HEAVY-DUTY BRAKES

**Continued from page 57**

Aluminum and copper clad drums are now in the development stage as possibilities of new materials appeals to some of the investigators working to improve vehicle equipment.

Another approach is *via* the exposed drum surface where the inside surface not covered by the lining was cooled by the surrounding air. Original shoes and liners were 116 deg long. These were shortened successively by 5 deg at each end, or a total of 10 deg, until only 56 deg of liner was left on each shoe, or a total of 112 deg.

Five hundred stops were made on a dynamometer setup, simulating transit bus service. Drum temperature decreased as liners were shortened which slowed liner wear, and air pressure needed to make the stop showed a decrease, Fig. 1. This indicated that braking was more effective with less lining.

Design of the Tru-Stop, American Chain & Cable, and the Duo-Grip have about 75% exposed drum surface, and only 25% lining coverage. Both are air cooled.

For greatest dependability and efficiency in brake operation supplementary units should be used to assist the wheel brakes. The use of electric, or dynamic, braking of trolley coaches has become universal in that field.

Supplementary water brakes, such as the Hydrotarder of Parkersburg Rig & Reel Co., and the electric Eddy Current unit of Warner Electric Brake Mfg. Co., both of which are mounted on the propeller shaft have given repeated demonstrations of the value of assisting wheel brakes.

A possible future development already being explored is a device related to the characteristics of torque converters. The idea of using stator blades of the converter as a stationary reaction member for energy absorption would use the converter as a supplementary brake.

Limitation of supplemental braking devices through the drive line is the strength of gear teeth in the rear axle drive gears. This strength is substantial and valuable.

Besides the possibility of lighter metals for brake shoes, is pressed steel in the interest of weightsaving. Aluminum drums have not performed as well as iron, and a cost and space penalty is imposed. It is possible that properly designed pressed steel would be as light as aluminum, and the cost would be closer to that of malleable or cast iron. Fatigue life would be high.

Automatic adjusting devices to maintain lining drum clearance on heavy duty brakes have seen little progress. Rachet devices lacking temperature compensation have been tried repeatedly, but with limited success. Use of such devices on light duty brakes is indicative of progress but the greatest need is on heavy duty equipment.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

# SAE Section

## WILLIAMS

### . . . . of Central Illinois

His keen memory developed partly by his story-collecting exploits has helped R. C. Williams more than a little in achieving success as an engineer.

Before his appointment as Assistant Director of Research at Caterpillar Tractor Co. in 1947, Russ was a field engineer in the Research Department. He traveled in each of the 48 states—Canada and Mexico as well—observing Caterpillar products at work. He once spent several frost-bitten weeks in mid-winter in Northern Canada with a tractor train. No doubt his adventures inspired numerous feats of the legendary Alexander Botts.

Treat of many engineering story-telling sessions is a sampling of his repertoire of humorous anecdotes, told in the inimitable Williams way. His fame as a story teller has spread far and wide. This prodigious memory and ability to note human foibles stand Russ in good stead in his daily work.

After spending eight years traveling, he finally settled down and became a family man. Now his home and young son are his chief hobbies, but he still is Caterpillar's champ story teller.

Russ was graduated from the University of Illinois in 1932 with a B.S. in Mechanical Engineering, and joined Caterpillar the same year. Though a one-company man, he has gained a unique experience with tractors, diesel engines, and earthmoving machinery through his wide travels.

During the past few years Russ has been very active in SAE technical committees; he has been a major influence in bringing to the tractor industry the same benefits SAE brought to the automotive industry. He has served on the Captured Enemy Equipment Committee, the Controlled Soil Vehicle Testing Committee, the Tractor Testing Committee, and the Spark Arrestor Committee of SAE.

At the Caterpillar Research Department, Russ has charge of all tractor research projects. He doesn't travel as much as he used to, but he still keeps in close touch with field tests at both the Peoria and Phoenix proving grounds. Russ and his staff of designers also plan the tractors and earthmovers of tomorrow that will literally change the face of the earth.

—Robert V. Larson, Field Editor

WILLIAMS

PUXON

## PUXON

### . . . . of British Columbia

Harold A. Puxon, young and able 1948-49 Chairman of the SAE's booming British Columbia Group, is a West Coast (and Canadian) authority on trailers. But it could have been plows. His present post at the top of the line in the manufacturing of highway equipment in the Canadian Pacific province is an accident, shy and retiring Harold takes pains to explain.

When a call came to the Vancouver Technical School auto mechanics class (where Harold was a student in the late twenties) for an apprentice in a local trailer manufacturing plant, the present Managing Director of the Columbia Trailer Company Ltd. quickly grabbed the opportunity. But, he claims, had it been a parts house or a plow-making plant, he'd have answered just as fast. Farmers might today be using Puxon-made plows instead of loggers toting ten-ton timbers to tidewater on Columbia-engineered trailers.

Puxon really got into the trailer game when Canada's road machinery organization—Sawyer-Massey—started building highway equipment in its Hamilton, Ontario, plant. But they soon decided graders, and not semi-trailers, was their specialty and boarded up the trailer branch. When Harold's old boss at Sawyer-Massey formed Shaw-Stewart at Vancouver to pioneer the building of trailers on the west coast, he joined the firm as a draftsman. But it too folded after three years.

Trailer-making was no closed chapter for Puxon however. Timber, the cornerstone of British Columbia's economy, was becoming more and more inaccessible by rail. Loggers were discarding their puffing "shays", studying the cheap flexibility of rubber-tired transportation in moving logs down the rugged mountains that disappear in the deep-water inlets of the rugged British Columbia coast.

With C. "Ed" Northrop, a former Shaw-Stewart fellow employee and current Secretary-Treasurer of Columbia Trailer Co. Ltd., a new line of logging trailers soon rolled through the

## Nov. 16 Is Set For 2nd Beecroft Lecture

COMMISSIONER Thomas H. MacDonald, veteran head of the U. S. Public Roads Administration, will be the second Beecroft Memorial Lecturer on Nov. 16 at a meeting of the SAE Washington Section in the Sapphire Room, Mayflower Hotel, Section Chairman Harold W. Evans announced.

"Chief" MacDonald was chosen by the SAE David Beecroft Traffic Safety Engineering Lecture Committee for his "meritorius contributions to the improvement of traffic conditions," the condition of the lectureship founded by the late David Beecroft, a past-president and for many years treasurer of the Society of Automotive Engineers.

Thirty years ago the commissioner was named to his present post, and he has devoted the major part of his career as an engineer and administrator to improving the nation's network of highways.

Chairman of the Lecture Committee is Pyke Johnson, president of the Automotive Safety Foundation. Committee members are Roy E. Cole, Automobile Manufacturers Association; Norman Damon, Automotive Safety Foundation; C. W. Phillips, American Association of State Highway Officials; the late Major H. G. Callahan, International Association of Chiefs of Police; H. S. Fairbank, U. S. Public Roads Administration and Otto F. Messner, American Association of Motor Vehicle Administrators.

# Chairmen

**These biographies are part of the series on 1948 - 1949 Section Chairmen**

tall timbers. Production line was sandwiched into rented space in an already-crowded machine shop. Engineering and administrative office was no larger than a piano box. Demand for Columbia trailers—logging, lowbed, and highway semitrailers—soon made expansion and erection of Columbia's own modern plant in Vancouver necessary.

Trailerman Puxon was active in the original formation of B. C.'s SAE Group. During its first year he acted as Program Chairman. Last year he was Vice-Chairman, before moving up as Chairman for the current season.

—J. B. Thompkins, Field Editor

## GUIOU

### . . . . of New England

Elty C. Guiou first came in contact with things mechanical as a warehouseman in a farm machinery transfer house in Aroostook County, Maine, during school vacation periods. He has been afflicted with the "machinery bug" ever since.

After getting his civil engineering degree from the University of Maine in 1917, Guiou served overseas in the Coast Artillery Corps in World War I. He returned to Presque Isle, Maine and for two years continued to assemble and service farm machinery and farm tractors.

He was lured to the Northwest in August, 1920. For two years he was instrument man, draftsman, and field estimator on land and timber surveys along the Fraser and Nechaco Rivers, in the Okanagen Lake area of British Columbia.

In 1923 he returned to the East to associate with the Outside Plant Engineering Department of the New England Telephone and Telegraph Co. He worked on construction specifications, tools, and labor saving equipment. Six years later he was appointed Motor Vehicle Supervisor of the company's Northern Area, assuming similar duties for the whole company in 1935.

Guiou became Division Supervisor of Vehicles for Metropolitan Boston in 1944 and two years later was transferred to the General Plant Department as Vehicle Supervisor. His duties: acquisition of new equipment and maintenance of the telephone fleet.

A bachelor, Elty gets a kick out of taking snap-shots in color. He recently acquired a movie camera with which he hopes to record activities at SAE outings and other gatherings.

Never having been anything but a very amateurish duffer at golf, he has transferred his physical exertions to sailing a small boat on a small pond over the summer week ends.

—Arnold R. Okuro, Field Editor

## WOODS

### . . . . of Pittsburgh

The automotive experiences of Charles W. Woods began in the days of the Model T Fords.

He used to rebuild them with overhead valves and race them on dirt tracks. After 14 years of automotive work in his own shop as well as those of others, he was appointed Coordinator of Automotive Transportation for the West Penn Power Co. He is in charge of the company's fleet of about 900 automotive vehicles, operating over more than 10,000 square miles and covering most of western Pennsylvania.

The practical influence injected in Section affairs by Woods and his fellow fleet men combines well with the active research interests of the membership. It tends to maintain that balance for which the Pittsburgh Section is noted.

A sports enthusiast, Charlie Woods favors baseball, football, hockey, and golf.

—Murray Fahnestock, Field Editor

GUIOU

WOODS

## You'll Be Interested To Know . . . . .

AT IT'S SEPT. 28 meeting, Council amended B-8 of SAE By-Laws to read: "Current dues, initiation fees, and fees for reinstatement shall be due and payable in accordance with schedules approved by the Council."

TO B. B. BACHMAN the SAE Council has conveyed its special appreciation for his services on the Board of Directors of the Cooperative Research Council, of which he was the first President and on which he served from its establishment in 1942 to the conclusion of his present term at the end of this year. The appreciation was "for the time and effort he has spent throughout many years of cooperative work between the petroleum and automotive engineers and executives since the Cooperative Fuel Research first came into existence in the early 20's. . . . R. L. Weider, White Motor Co., has been appointed to succeed Bachman for the two-year term beginning Jan. 1, 1949, while C. E. Frudden and E. S. MacPherson were reappointed for the new two-year term. . . . SAE members of the CRC Board who still have one year to serve are: J. M. Crawford, R. D. Kelly, Arthur Nutt, and J. C. Zeder.

J. M. CRAWFORD, vice-president of engineering, General Motors, has been appointed a member of the SAE Finance Committee. An SAE Past-President, Crawford takes the place made vacant by the resignation of E. R. Breech, executive vice-president, Ford Motor Co.

J. M. Crawford

GENERAL CHAIRMEN have been named for several important SAE National Meetings next year. Included are E. N. Cole of Cadillac for the Passenger Car, Body, and Production Meeting; R. E. Minton of Curtiss-Wright for the Aeronautic and Air Transport Meeting (New York); and Z. C. R. Hansen, Automotive Equipment Co., for the West Coast Meeting.

### Central Illinois—Nov. 15

Elks Club, Springfield, Ill.; dinner 6:30 p.m. Meeting 7:45 p.m. Dinner speaker: Impressions of Sweden and France—Dr. R. Wiebe, National Delegate. The Customer's Evaluation of Present Earthmoving Equipment—Jim Symonds, Peter Kewitts Construction Co. Technical Chairman: John Liggett, Allis-Chalmers Mfg. Co.

### Chicago—Nov. 9

Hotel Knickerbocker; dinner 6:45 p.m. preceded by social half hour. Newer Developments in Glass—Robert A. Miller, technical sales engineer, Pittsburgh Plate Glass Co. Technical chairman: W. W. Smith, executive engineer, Studebaker Corp. and SAE Section vice-chairman for Passenger Cars.

### Cleveland—Nov. 8

National Advisory Committee for Aeronautics, Cleveland Airport; dinner 6:30 p.m. Rocket Propulsion—John Sloop, Rocket Research Section N.A.C.A. Sponsor: E. J. Manganiello, chief of Thermodynamics Branch N.A.C.A. Closed meeting (limited to first 200 reservations). Tour of laboratory (restricted).

### Detroit—Nov. 15

Large Auditorium, H. H. Rackham Educational Memorial; dinner 6:30 p.m. Dinner speaker: James Henderson, Thompson Products, Inc. to speak on "Moose Hunting—Indian Style." Film in color. Technical session 8:00 p.m. Are We Doing A Good Job on Body Interiors?—George W. Walker, Walker Design Studios; Helene Rother, Rother Design-Styling Studios; James Watt, formerly director of purchases of interior trimming materials, Ford Motor Co.

### Metropolitan—Nov. 18

Hotel Pennsylvania; meeting 7:45 p.m. Guided Missiles—Capt. D. S. Fahrney, U. S. Navy chief of Pilotless Aircraft Division, Bureau of Aeronautics.

### Mohawk-Hudson Group—Nov. 10

Hotel Wellington, Albany, N. Y.; dinner 6:30 p.m. New Automotive Developments—Austin M. Wolf, automotive consultant.

### Northern California—Nov. 15

Engineers Club, San Francisco; dinner 6:30 p.m. Transportation and Maintenance meeting. Speaker and subject to be announced.

### Philadelphia—Nov. 10

Engineers Club; dinner 6:30 p.m. Meeting 8:00 p.m. Air Brakes, Design and Performance, Past, Present, Future—Stephen Johnson, Bendix-Westinghouse Air Brake Co. Motion picture supplement on same subject.

### Pittsburgh—Nov. 23

Hotel Webster Hall; dinner 6:30 p.m. preceded by social period at 6:00 p.m. Meeting 8:00 p.m. Alternating Current Generating Systems for Automotive Vehicles—Albert D. Gilchrist, chief engineer, Leece-Neville Co., Cleveland.

### St. Louis—Nov. 2

Garavelli's; dinner 6:30 p.m. Developments in Fuels, Lubricants and Lubrication—R. J. S. Pigott, chief engineer, Gulf Research and Development and president, SAE.

### Southern California—Nov. 18

Rodger Young Auditorium, Los Angeles; dinner 6:30 p.m. Transportation and Maintenance meeting. Truck Engineering—John Holmstrom, vice-president, Kenworth Motor Truck Co.

### Southern New England—Nov. 4

Lounge Room, Hotel Sheraton, Springfield, Mass.; dinner 6:45 p.m. preceded by social half hour at 6:00 p.m. (sponsored by American Bosch Corp.). Diesel and Gasoline Motorcoach Powerplants—M. C. Horine, Mack Mfg. Corp. Technical chairman: Hans Hogeman, American Bosch Corp. Inspection trip through American Bosch Corp. plant at 3664 Main St., Springfield, Mass. starting at 2:30 p.m.

### Spokane-Intermountain—Nov. 12

Hotel Spokane; speaker and subject to be announced.

### Wichita—Nov. 10

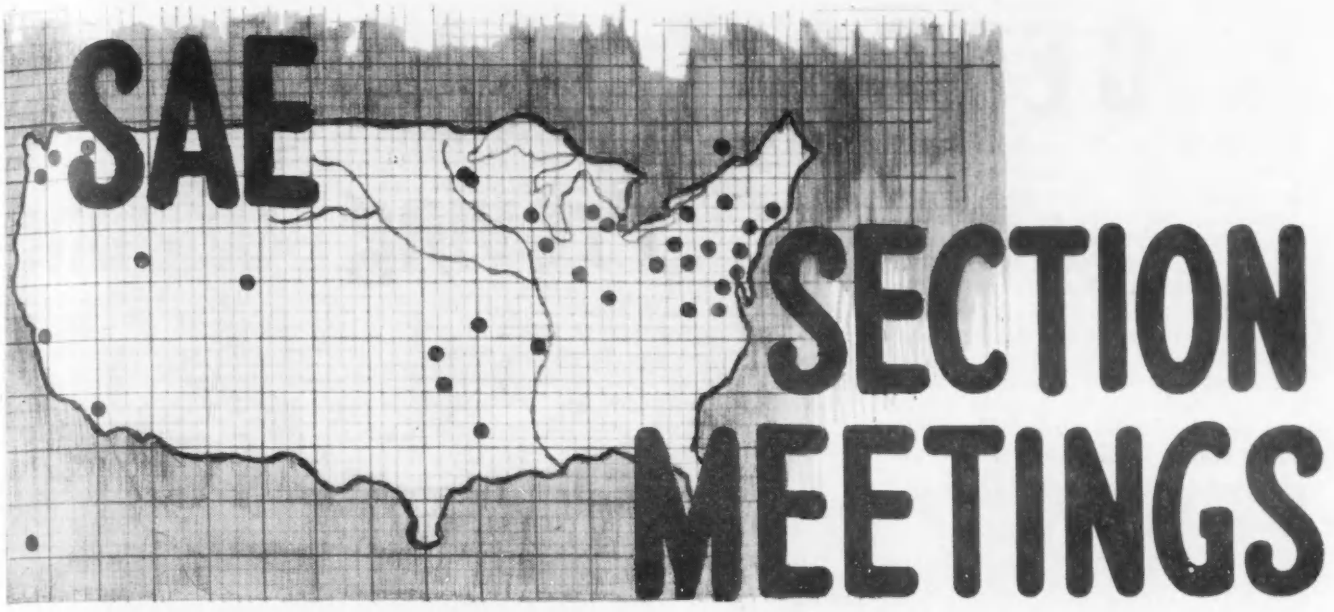
Dinner 6:30 p.m. Developments in Fuels, Lubricants and Lubrication—R. J. S. Pigott, chief engineer, Gulf Research and Development and president, SAE. Presentation of past-chairman certificate.

### Washington—Nov. 16

Sapphire Room, Hotel Mayflower; dinner 7:00 p.m. preceded by social half hour at 6:30 p.m. Second Beecroft Memorial Lecture—Commissioner Thomas H. MacDonald, U. S. Public Roads Administration.

## NATIONAL MEETINGS • 1949

| MEETING | DATE | HOTEL |
|---|---|---|
| ANNUAL MEETING and Engineering Display | Jan. 10-14 | Book-Cadillac, Detroit |
| PASSENGER CAR, BODY, and PRODUCTION | March 8-10 | Book-Cadillac, Detroit |
| TRANSPORTATION | March 28-30 | Statler, Cleveland |
| AERONAUTIC and AIR TRANSPORT and AIRCRAFT Engineering Display | April 11-13 | New Yorker, New York |
| SUMMER | June 5-10 | French Lick Springs, French Lick, Ind. |
| WEST COAST | Aug. 15-17 | Multnomah, Portland, Oreg. |




## Farrell Receives SAE Golf Trophy

—R. L. SMIRL, Field Editor

CHICAGO, Sept. 24—Highlight of the fifth annual Play Day Event of the Chicago Section was the presentation of the SAE Golf Trophy to the first three-time winner at the national Summer Meetings.

Frank E. Farrell, assistant director of sales for Bendix Products Division won the event for three consecutive years at French Lick to become the permanent possessor of the coveted trophy, which has been in competition for nearly 20 years.

For two prior years the trophy was held by A. T. Colwell, vice-president of Thompson Products, Inc. Presentation was made at the Chicago event by W. K. (Bill) Creson, vice-president of Ross Gear & Tool Co., who handles golf almost as well as he does steering geometry.

In addition to door prizes representing more than $2500 in merchandise and war bonds, there were 50 golf prizes awarded for this Chicago meeting, which was attended by a record crowd of 360. Farrell also won this event and received a Mixmaster for the lowest gross score, a 74 in spite of the stiff north breeze and musical hecklers at the tee-off. A similar prize was won by the lowest-scoring guest, Bill Francis, with a score of only 70.

Other prizes were based on the Peoria Handicap System, starting with a handsome travelling bag presented to Jack Cole for a low net score of 55.

Dinner and entertainment concluded the program with Tommy Bartlett, star of the ABC "Welcome Travellers" show, acting as MC. He was assisted by Les Lear and Sam Eadie of the same show, in an audience participation game of "Name It and You Can Have It," which wound up with the first 12 door-prize winners holding an assortment of animals from a squealing pig down to a handful of fish worms.

## Hutchinson Reviews Valve Gear Design

—H. F. STAPEL, Field Editor

WESTERN MICHIGAN Section, Sept. 23—Although R. V. Hutchinson insisted there was nothing new in his "Random Notes on Valve Gear," much of it was new to his listeners.

Hutchinson, assistant chief engineer of the Automotive Ordnance Branch of General Motors Corp., explained that as compression ratio increases, smaller exhaust valves can be used.

Reason is that the main mass of exhaust gas escapes from the cylinder early during the exhaust opening, and the moving piston has little trouble in expelling most of the remainder. But at or near top center, further scavenge depends largely on expansion of the residue, and the exhaust valve is lifted very little.

With higher compression ratios, he said, the lower exhaust gas temperatures and smaller, cooler exhaust valves can discourage detonation.

Hutchinson interpreted some of Midgely's work on heat transfer to show that valve head cooling should improve with seating force.

## 8th Air Force Adds B-36 and B-50 to B-29

—J. W. WALKER

TEXAS Section, Sept. 10—The Eighth Air Force is prepared to conduct long-range operations at any point on the globe at any time, members learned from Brig.-Gen. Robert W. Burns.

The B-29 Superfort is still the backbone of the Eighth's present strength, but it is being augmented rapidly by the B-36 and the improved version of the Superfort, the B-50, Burns said, adding that recently a B-36 flew more than 8000 miles with a 10,000-lb bomb load. He named the B-50's longer range and greater carrying capacity at higher altitudes as its advantages over the B-29.

Lt. Comdr. H. S. Nelson described plans for stockpiling essential materials and preparing manufacturers for the contracts that will be made in case of emergency.

## Vaughan at Hawaii on Radiological Defense

—RENE GUILLOU, Field Editor

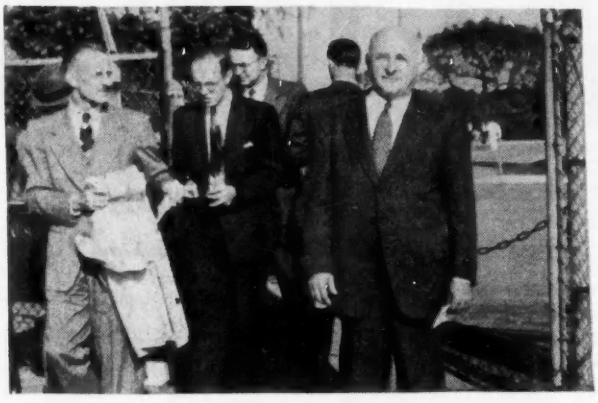
HAWAII Section, Sept. 20—Lt. Col. L. J. Vaughan's talk on "Radiological Defense" was accurately subtitled by one of his listeners as "What an intelligent citizen should know about atomic bombs."

Vaughan, Air Chemical Officer, Pacific Air Command, U. S. Air Force, described the emergency measures that

**Turn to P. 79**

# DETROIT SAE Visits Proving Ground

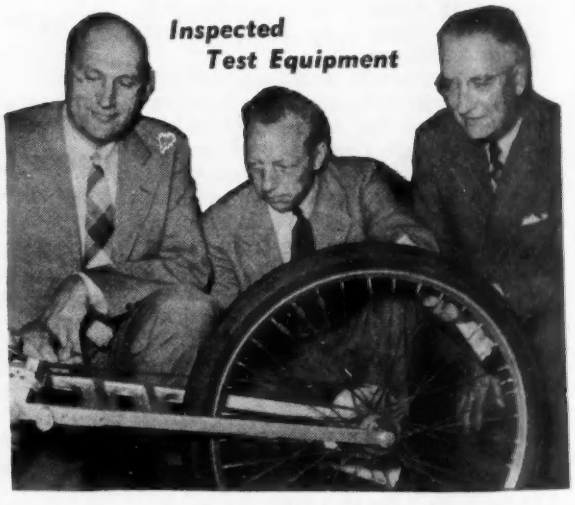
*They Came in Groups . . .*



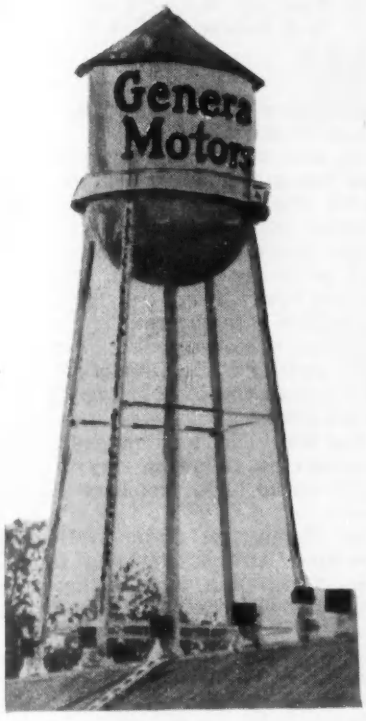
*Took Special Buses . . .*

*. . . Toured the 1200 Acres*

*Inspected Test Equipment*



*Had Barbecued Dinner In Modernistic Tent*




General Motors Corp. was host to Detroit SAE members at a visit to its 24 year-old, 1200 acre Proving Ground on Friday, Oct. 1—an event which turned out to be one of the most enthusiastically attended gatherings in Detroit Section history. More than 1,000 journeyed to Milford to tour the 25 miles of varied roads and inspect the multitude of testing equipment at the Proving Ground.

Climax was dinner in a great modernistic tent (developed by GM for use with its traveling exhibits) where GM President C. E. Wilson welcomed his fellow SAE members and talked to them about "Engineers as I Know Them." GM Executive Vice-President O. E. Hunt, celebrating his 65th birthday, was toastmaster. Detroit Section Chairman E. P. Lamb of Chrysler opened the dinner proceedings by thanking General Motors in the name of the Section for its hospitality and then introducing Toastmaster Hunt.

### Wilson Reminisces

Reminiscing about his early days as an electrical engineer, Wilson recalled and endorsed the recipe for success in engineering given him by the chief engineer of Westinghouse Electric years ago. That chief engineer, Wilson related, rated young men on five things: mental capacity, technical or formal education, working experience, ability to get along with people, and attitude toward work. "In the 40 years since," Wilson said, "I haven't been able to develop any better formula for judging a man—and especially an engineer.

"Engineers in their training and in their work," he continued, "develop an ability to see ahead—and a great respect for the truth and the facts. They are forward looking. They make successful realities of their visions. American engineers have done more than their part in making our country what it is."

***Heard Wilson, Lamb, and Hunt . . .***

**Continued from P. 77**

would be taken by a disaster team, following an atomic bomb attack on an American city.

According to Vaughan, such a bomb would presumably be detonated about 3000 ft above the ground. All structures within a half mile of the point directly beneath the explosion would be completely destroyed by the blast and heat.

In a second zone half a mile wide, Class A and Class C buildings would be seriously damaged, while lighted structures would be wrecked, and all combustible materials exposed to the radiation would be ignited. For another mile from the explosion center, concrete construction would not be seriously damaged, but lighted construction would suffer severely and many fires would break out. A conflagration would generally result, and the first aim of damage control would be to restrict the fire losses.

Persons exposed to direct radiation from the explosion would receive severe surface burns from the radiant heat and light, and in many cases would be temporarily blinded by the light, Vaughan continued. Alpha and beta radiations have low penetrating power and seldom cause direct injury, but material exposed to these particles becomes radioactive. Alpha or beta particles are dangerous if taken into the body through the lungs, digestive tract, or skin.

Once these particles are in the human system, ionization of the blood stream occurs with attendant destruction of tissue and bone structure. Affected clothing should be discarded, and exposed skin surfaces should be cleaned by scrubbing, using a mixture of lanolin and corn meal, followed by repeated soap and water washings.

Discussing gamma-ray radiation from the initial explosion and from radioactive material, Vaughan said that such radiation is penetrating and is believed capable of causing severe internal injury, for which removal from affected areas and rest is the recognized treatment. He explained that exposure to gamma radiation is measured in Roentgens. An exposure of 0.1 Roentgen in 24 hr is considered harmless to humans. From 100 to 300 Roentgens in 24 hr may cause serious injury, from 300 to 600 Roentgens in 24 hr may cause death, while persons exposed to over 600 Roentgens in 24 hr would seldom recover. Responsibilities of a disaster team would include cleaning up exposed persons and treating them for burns and shock, and in posting warnings about areas where radiation exceeded 12½ milli-Roentgens per hr as measured with Geiger counters. Men engaged in this work would wear gas masks and protective clothing to avoid contamination with radioactive material, and would have to avoid gamma ray injury by keeping out of radioactive areas as much as possible, he said.

In answer to questions, Vaughan explained that the distribution of radioactivity following a bomb detonation would depend largely on the settling of radioactive dust, and on the precipitation of radioactive water. The exact shielding required to protect a person from the initial radiation is not made public, but Vaughan said that a person nearby and shielded by 5 or 6 ft of earth, or directly exposed at a distance of 6 to 8 miles, would probably not suffer injury from direct radiation. Shielding within the immediate blast area would presumably be demolished, however, he said, adding that lead shielding is effective in resisting the penetration of gamma rays because of

As President Pigott and his daughter, Miss Patricia Pigott, arrived in Honolulu, they were greeted by B. J. Eaves, left, S. J. Miehlstein, T. F. Pryor, Ned Meisner, J. W. Rogers, Mrs. G. R. Meisner, and G. R. Meisner

its density, and other materials of high density also show promise. Greater thickness of low-density material would have to be employed to afford the same protection, he said.

Hawaii Section enjoyed a visit with President R. J. S. Pigott in August and September. Pigott spent a week on the island of Oahu, in the course of which he was shown sugar and pineapple plantations, went through sugar mills and the world's largest cannery (pineapples), and met the Board of Governors of the Hawaii Section at a cocktail party, besides being plied with questions about fuels and lubricants far into the night by 140 members and their guests at a dinner meeting in Honolulu.

Accompanied by John Rogers, Rae Meisner, and Mrs. Meisner of Honolulu, President Pigott and his daughter flew to the island of Hawaii. The party was met at the Hilo airport by members of the Hilo Division and their wives, where they were bedecked with orchid leis and given the freedom of the island in the shape of a car for the duration of their stay—an aloha from a loyal local automotive firm.

The group inspected the craters, lava tubes, and fern forests of the Kilauea Volcano; viewed motion pictures of the 1942 eruption; and spent a day on the Kona Coast, famous for its coffee plantations and picturesque fishing villages.

Rogers, who knows Hawaii intimately, drove the visitors to a point on a cliff from which they looked down into a natural basin of clear sea water and within a few minutes saw most of the many species of curious and colorful Hawaiian fish. This spot is practically unknown even to old residents of the islands.

The return to Hilo was over deserts and cattle ranges on the lee side of the island and then through the rain-soaked forests and sugar plantations to windward. A dinner meeting attended by 49 members of the Hilo Division enjoyed Pigott's penetrating and humorous discussion of automotive products of the petroleum industry.

The party flew from Hilo to the island of Maui, to be met again at the airport and decked with flowers by enthusiastic SAE members. Points visited here were sugar and pineapple plantations and the 10,000-ft high crater of Haleakala.

It was with some misgivings that this volcano, now extinct, was visited in the afternoon, when it is frequently covered with clouds from the rising trade winds. Pele, the volcano goddess, evidently intervened. The clouds cleared away from the huge crater, one of the rare silversword plants was in bloom, and even a flock of mountain goats exhibited themselves. They are seldom seen except in the remote parts of the crater.

The Maui District arranged a dinner meeting the following day at which Pigott spoke to 51 members and their guests.

On the return flight to Honolulu, Hawaiian Airlines deviated from its usual flight plan to take the visitors along the windward coast of Molokai island.

Inaccessible by surface transportation and not seen from the commercial air routes, this coast is remarkable for 3000-ft cliffs cut by the trade-wind surf, over which pour waterfalls from the rain forest above.

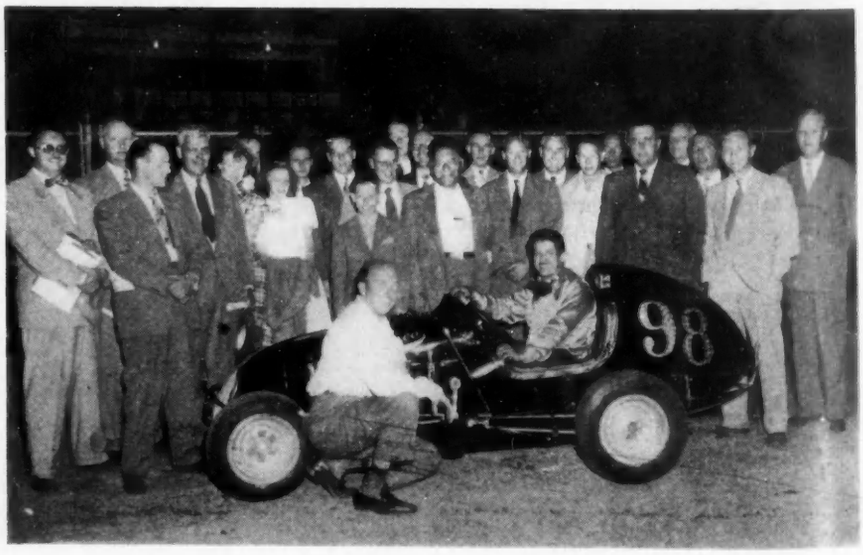
## Group Tours Pits at Midget Raceway

—R. G. SHANKLIN, Field Editor

MOHAWK-HUDSON Group, Aug. 11—The Group entertained owners and

Cont. on page 86

The Mohawk-Hudson Group gathers around a midget racing car at Empire Raceways, Menands, N. Y.



# CRC Accumulated Wartime Technical Reports

## 1942-1946, Inclusive

FOLLOWING is a list of the Coordinating Research Council's Accumulated Wartime Reports, 1942–1946, inclusive. Many of these may be had from the SAE Special Publications Department, 29 West 39th Street, New York 18, N. Y., as long as the supply lasts.

Those marked with an asterisk (*) are available in photostatic form only. Prices of the individual reports will be furnished upon request.

New CRC Reports will be announced in future issues of the SAE Journal as soon as they have been released.

## EQUIPMENT

Preparing Stored Passenger Automobiles for Service. **CRC-1.*** 11/9/42

Recommendations on Cold Engine Oil Sludge Control. **CRC-2.*** 9/17/43

Report of Meeting and Inspection Trip on Effect of High Lead Concentration in Gasoline on Engine Maintenance. **CRC-3.*** 10/5/43

Engine Oil Filters in Military Motor Vehicles (SAE-WEB Report prepared for CRC). **CRC-4.*** 11/12/43

Recommendations Covering Ordnance Specification for Testing Engine Oil Filters (SAE-WEB Report prepared for CRC). **CRC-5.*** Jan., 1944

Results of Survey on Gasoline Engine Oil Ring Plugging. **CRC-6.*** 1/24/44

Summary of Observations Made at Tank Automotive Center Winter Test Command. **CRC-7.** 2/26/44

Statement on Operation and Maintenance of Civilian Vehicles under War Restrictions. **CRC-8*** 4/14/44

## FUELS

### AVIATION FUELS

#### Cooling Liquids

Properties of Ethylene Glycol and its Aqueous Solutions. **CRC-9.** Aug., 1943

A Theoretical Investigation of Cavitation in Aircraft Engine Coolant Pumps. **CRC-10.*** 8/9/44

Summary Report on Work of the Corrosion Group, CFR-AFD Cooling Liquids Projects. **CRC-11.*** 2/7/45

#### Full-Scale Detonation

Memorandum on Full-Scale Multi-Cylinder, Full-Scale Single-Cylinder and Laboratory Knock Ratings, including report of the Analysis Panel of the CFR-AFD Full-Scale Detonation Single-Cylinder Engine Group on Relation Between Fuel Anti-Knock Ratings as Obtained on Full-Scale Multi, Full-Scale Single and Laboratory Engines (PPF Fuels, 1941-42). **CRC-12.*** 5/27/43

Report on Analysis of Existing Full-Scale Engine Detonation Test Data. **CRC-13.** 2/29/44

Report on the Testing of CFR-AFD Fuels 30-41 Inclusive, in Full-Scale Single-Cylinder Engines. **CRC-14.** 3/21/44

Report on Analysis of Full-Scale Engine Detonation Test Data Available as of July 15, 1944. **CRC-15.*** 9/12/44

Report on Analysis of Full-Scale Engine Detonation Test Data from the 1944 CFR-AFD Program. **CRC-16.** March, 1946

Report of Full-Scale Single-Cylinder Engine Group. **CRC-17.** 5/13/46

Report on Knock Intensity. **CRC-18.** 7/15/46

Measurement of Knock Intensity and Engine Deterioration by the DTI Method (Supplement to Report on "Knock Intensity."—July 15, 1946). **CRC-18A.** 11/26/47

#### Gasoline Additives

Progress Report of the CS Panel, Gasoline Additives Group. **CRC-19.** 12/1/43

Results of Preliminary Survey to Determine the Prevalence of Deposition in Fuel Induction Systems of Aviation Engines. **CRC-20.*** 1/5/45

Report on 1944 Desert Storage Tests on Aviation Gasolines With and Without CS. **CRC-21.** 6/23/45

Report on Work of the Copper Dish Corrosion Panel, CFR-MFD Gasoline Additives Group, from June 1944 to November 1945. **CRC-22.*** 11/27/45

Supplement to Report on 1944 Desert Storage Tests on Aviation Gasolines With and Without CS. **CRC-23.** July, 1946

#### Laboratory Detonation

Precision of Rating Aviation Fuels, 1942-44. **CRC-24.*** 1/7/45

Report on Tests of LSMT and Leaded Triptane-Heptane Blends. **CRC-25.** 5/7/45

Report on Tests of Aviation Precision Samples. **CRC-26.** 5/17/45

Physical Properties of Triptane and the Variation of these Properties with Small Amounts of Impurity. **CRC-27.** 8/8/45

Correlation of F-2 and F-3 Ratings of Fuels and Components. **CRC-28.** 2/8/46

Effect of Knockmeters on Reproducibility of F-4 Procedure. **CRC-29.** 3/28/46

Analysis of Reference Fuel Framework Data Obtained on CRC EF-4 Engines by the CFR-AFD Laboratory Detonation Projects Operation and Maintenance Group. **CRC-30.*** 5/2/46. Supp. 7/23/46

Precision of Rating Aviation Fuels, 1945. **CRC-31.*** 5/24/46

Report on Calibration of Leaded Triptane-Heptane Blends. **CRC-32.**

* Available only in photostatic form.

5/31/46

Final Report on Precision Obtained with LST/LMT Blends. **CRC-33.*** 5/31/46

## Vapor Lock

Effect of Change in the Fuel Specification on Carburetor Metering. **CRC-34.*** Rev. 3/21/44

## Pressure Drops in Component Parts of Fuel Systems

Analysis of Flow Data on 5/8" Fuel System Tubing, Fittings and Accessories (I-1). **CRC-35.*** 11/20/39

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Analysis of Flow Data on 3/4" Tubing, Fittings and Accessories (I-3). **CRC-37.** 12/23/39

Analysis of Flow Data on Fuel System Connectors and Unions (I-4). **CRC-38.** 12/29/39

Supplementary Analysis of Flow Data on 5/8" Tubing, Fittings and Accessories (1-5). **CRC-39.** 1/6/40

Analysis of Flow Data on 5/8" Accessory Fittings (I-6). **CRC-40.** 1/24/40

Analysis of Flow Data on 3/4" Accessory Fittings (I-7). **CRC-41.** 2/19/40

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Correlation of Data on 45° Elbow Tube-to-Tube Fittings (I-17). **CRC-51.** 5/22/40

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Summary Report on Parker Hose Fittings (I-28). **CRC-62.** 10/10/40

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Change of Vapor Pressure with V/L Ratio for Commercial Aviation Gasolines (II-2). **CRC-64.*** 6/5/40

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Change in Octane Number of Aviation Fuel with Evaporation Loss (II-10). **CRC-72.** 1/8/42

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Fuel Changes in Tank During Flight with 120° Initial Fuel Temperature (Appendix to II-11). **CRC-74.*** 6/5/42

The Effect of Fuel Characteristics on the Vapor Locking Tendency of Aviation Gasolines (II-12). **CRC-75.** 1/22/42

Preliminary Report on Group Cooling of Aviation Fuel (II-13). **CRC-76.** 2/9/42

The Effect of Air Solubility on the Vapor-Locking Tendency of Aviation Gasolines (II-14). **CRC-77.** 3/11/42

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Survey of Commercial Aviation Gasolines (1943 Production) (II-21). **CRC-84.** 1/17/44

A Summary of Aviation Fuel Characteristics from 1940-1943 (II-22). **CRC-85.** 12/16/43

Survey of Aviation Fuel Characteristics (91 and 100 Octane Number Fuels) (II-23). **CRC-86.** Rev. 8/27/46

Survey of Aviation Fuel Characteristics (January 1945, 100 Octane Number Fuels) (II-24). **CRC-87.** Rev. 8/10/45

Survey of Aviation Fuel Characteristics (March 1945, 91 Octane Number Fuels) (II-25). **CRC-88.** Rev. 8/27/46

Fuel Vapor Viscosities (II-26). **CRC-89.** 9/11/45

Survey of Aviation Fuel Characteristics (January 1946 Production; 100/130 and 91/98 Grade Fuels) (II-27). **CRC-90.** 3/14/46

## High Altitude Vapor Lock Problems

High Altitude Vapor Lock Problem (III-1). **CRC-91.** 11/20/39

High Altitude Vapor Lock Problem (Report for Presentation at SAE National Aircraft Production Meeting, Los Angeles, November 1, 1940) (III-2). **CRC-92.*** 10/24/40

Report on Measurements of Loss of Fuel Through Evaporation During Simulated High Altitude Flights (III-3). **CRC-93.** Rev. Aug., 1944

The Control of Fuel Evaporation Losses During High Altitude Flights by Means of Vapor Condensing Coolers (III-4). **CRC-94.** 8/4/44

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Preliminary Analysis of Vapor Condensing Cooler and Fuel Cooler Heat Transfer Data to Prevent Fuel Evaporation Loss During Flight (III-6). **CRC-96.** Rev. 6/1/45

The Effect of Aviation Fuel Characteristics on Vapor Lock (III-7). **CRC-97.** May, 1945

The Occurrence of Explosive Mixtures in the Vapor Space of Airplane Fuel Tanks (III-8). **CRC-98.** 1/6/45

Evolution of Air from Supersaturated Fuel During Climb (III-9). **CRC-99.** 9/11/45

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Memorandum on a Survey of the EAD Test Data on Various Aviation Gasolines Obtained in the Current Test Program of the CFR-AFD and MFD Equilibrium Air Distillation Group. **CRC-109.*** 5/3/44

Application of Equilibrium Air Distillation Data to Flight Test Volatility Studies. **CRC-110.*** 8/23/45

A Prediction of the Effect of High Boiling Constituents on the Performance of Aviation Gasoline by the Use of Equilibrium Air Distillation Data. **CRC-111.*** 9/25/45

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Evaluation of Diesel Fuels in Full-Scale Engines. **CRC-112.*** 9/4/42

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Report of Group Working on Minimum Cetane Number for Emergency Diesel Fuel. **CRC-114.*** 5/5/43

Report of CFR Automotive Diesel Fuel Rust Preventive Storage Stable Fuel Group. **CRC-115.*** 9/16/43

Summary Report on 35 Cetane Number Diesel Fuel Tests. **CRC-116.*** 10/27/43

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The Precision of Rating Diesel Fuels, 1942-44. **CRC-118.** 3/17/45

Report on Minimum Viscosity Limits for Automotive Diesel Fuels. **CRC-119.** 3/29/45

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Ordnance Storage Tests of Diesel Engines Using AXS-1514 Diesel Fuel for Engine Runout. **CRC-122.** 8/15/46

## Motor Fuels

### Engine Varnish and Sludge

Effect of Fuel on Engine Varnish and Sludge. **CRC-123.** Rev. 2/11/46

Report of Analysis Panel—Engine Varnish and Sludge Group. **CRC-124.** 3/15/46

Report of the Analysis Panel — Engine Varnish and Sludge Group. **CRC-125.** 3/15/46 Rev. 12/30/46

### Full-Scale Detonation

Fuel Octane Number and Vapor Pressure Requirements for Quartermaster Corps Motor Vehicles. **CRC-126.** 6/20/42

Recommendations Relative to Octane Number of Gasoline (SAE-WEB Report prepared for CRC). **CRC-127.*** June, 1943

Test Procedure and Recommended Policies Related to Detonation in Military Engines Used in Ground Vehicles. **CRC-128.** 7/15/43

Effect of Octane Number on Engine Torque, Effect of Detonation on Engine Life, Effect of Changes in Intake Air Temperature on Engine Power and Borderline Knock. Compression Ratio, Ford GAA Engine. **CRC-129.** 5/1/44

Octane Requirements of Civilian Passenger Cars, Trucks and Busses (SAE-WEB Report prepared for CRC). **CRC-130.** Aug., 1944

Military Vehicle Manufacturers Octane Requirement Recommendations for Gasoline Engines (SAE-WEB Report prepared for CRC) **CRC-131.** Aug., 1944

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Report on a Method for Specifying Oxidation Stability and Stability Requirements for Ordnance Single Universal Motor Gasoline. **CRC-132.*** 3/10/43

Memorandum on the Possible Use of Chloroform as a Supplementary Agent for U. S. Army All-Purpose Motor Gasoline U. S. Army Specification 2-103B as Furnished for British Civilian Use. **CRC-133.*** 2/23/44

80 Octane Motor Fuel Survey—European Theatre—U.K. **CRC-134.*** March, 1944

80 Octane Motor Fuel Survey—North American Theatre. **CRC-135.*** March, 1944

Report on Field Model Apparatus for Determination of Gum in Gasoline. **CRC-136.*** 8/4/44

1943 Desert Storage Tests of 80 Octane Number All-Purpose Gasoline. **CRC-137.** Sept., 1944

Report on Gasoline Storage in Army Vehicles at Detroit, Mich. **CRC-138.** 1/2/45

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Report on Maximum Allowable Antioxidant Content Test in Ordnance Materiel—Tests Conducted at Camp Bullis, San Antonio, Texas (April 16, 1945 to June 1, 1945) **CRC-140.** Rev. 11/15/45

Report on Gasoline Gum Tolerance of Ordnance Material — Tests Conducted Normoyle Field, San Antonio, Texas (October 15, 1944 to January 15, 1945) **CRC-141.** Rev. 6/19/45

Supplementary Report on Gasoline Storage in Army Vehicles at Detroit, Mich. **CRC-142** 8/7/45

Report on Gasoline Storage in Army Vehicles at Detroit, Mich. **CRC-143.** 2/2/45

Supplementary Report on Gasoline Storage in Army Vehicles at Detroit, Mich., August 7, 1945. **CRC-144.** 8/7/45

Report on Maximum Allowable Antioxidant Content Test in Ordnance Materiel (Tests Conducted at Camp Bullis, San Antonio, Texas) (April 16, 1945 to June 1, 1945). **CRC-145.** 7/14/45 Rev. 9/10/47

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### Motor Gasoline Survey[1]

Report of Investigations—Cooperative Fuel Research Motor Gasoline Survey, Winter 1942-43. **CRC-148.*** June, 1943

Report of Investigations—National Motor-Gasoline Survey, Summer 1943. **CRC-149.*** Dec., 1943

Report of Investigations—National Motor-Gasoline Survey, Winter 1943-44. **CRC-150.*** May, 1944

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Report of Investigations—National Motor-Gasoline Survey, Winter 1944-45. **CRC-152.** June, 1945

Report of Investigations—National Motor-Gasoline Survey, Summer 1945. **CRC-153.*** Jan., 1946

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### Sulfur

Report of CFR Motor Fuels Division Group on Sulfur in Motor Gasolines. **CRC-155.*** 9/30/43

Discussion of Sulfur Limits for Army Motor Gasolines. **CRC-156.** 12/11/44

### Volatility

Engine Starting Tests on M41A Tanks.

[1] Published by the Bureau of Mines, Department of Interior, Washington 25, D. C., in cooperation with the Coordinating Research Council. Copies available through the Bureau.

**CRC-157.*** 11/20/42

Memorandum on Substitution of Propane for Butane in Motor Fuels. **CRC-158.*** Dec., 1942

Correlation of Gasoline Vapor Forming Characteristics with Inspection Test Data (Report No. 1). **CRC-159.*** 1/28/43

Occurrence of Vapor Lock as Related to the Temperature—V/L Characteristics of Motor Gasolines (Report No. 2). **CRC-160.** 6/18/43

Report of CFR-MFD Volatility Projects Group on Practicability of Raising 50 and 90 per cent Temperatures for Domestic Gasolines. **CRC-161.*** 9/30/43

Analysis of Vapor Lock Tests of Several U. S. Army Ordnance Vehicles as Related to U. S. Army Specification 2-103B (Report No. 3). **CRC-162.** 2/26/44

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Effect of Octane Number and Volatility on Horsepower and Fuel Economy of Tractor Engines. **CRC-163.** 8/23/45

## Non-Petroleum Fuels

### Alcohol-Gasoline Blends

Report on Alcohol and Alcohol-Gasoline Blends. **CRC-164.** 5/23/45

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Crankcase Oil Reclaiming and Refining. **CRC-167.*** 3/23/42

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Summary of Test Results Obtained by Participating Laboratories on Test Oils for Moderate Duty Gasoline Engines. **CRC-169.*** 4/15/42

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Engine Tests of Lubricating Oils. **CRC-174.*** 2/14/44

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Report of CLR Group Investigating the Use of 2-104B Oil in Two-Cycle Engines. **CRC-177.*** 3/16/44

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Report of Procedure Panel for Moderate Load and Temperature Conditions, Oxidation Tests Group, CLR Engine Oil Division. **CRC-180.*** 6/20/45

Recommendations of the Group on Oil Temperature Limits for Diesel Engine Driven Generator Sets. **CRC-180.*** 9/21/45

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Summary of Data from Ordnance Department's Report on Cold Weather Testing of Lubricants, Automotive, Pertaining to Gear Lubricants. **CRC-183.*** 7/16/43

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Report on 15,000 Mile Endurance Tests on CLR Gear Lubricants. **CRC-185.*** 7/10/44

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Report on Development of a High Speed Axle Test Procedure. **CRC-187.*** 5/4/45

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Chassis Lubrication and Maintenance Recommendations for Vehicles in Storage (CLLG-1-42). **CRC-188.** 12/26/42

Rust-Inhibiting Greases for Use in Stored Vehicles (CLLG-2-42). **CRC-189.** 12/26/42

Final Report on Extreme Pressure Greases for Worm Gears (CLLG-3-42). **CRC-190.** 8/17/44

Low Temperature Torque Tests (CLLG-4-42) First Report **CRC-191.** March, 1943. Second Report **CRC-192.** Nov., 1943. Third Report **CRC-193.** March, 1944. Fourth Report **CRC-194.** Aug., 1944

Lubrication Instructions—Wheel Bearings (CLLG-6-42). **CRC-195.** 8/1/43

Storage Stability of Lubricating Grease (CLLG-9-43). **CRC-196.** March, 1943

Tendency of Lubricating Greases to Separate Oil at Elevated Temperature Under Static Conditions (Cone Oil-Bleeding Test) (CLLG-10-43). **CRC-197.** 1/26/44

Final Report on Grease Dispensing Tests — Alemite Dual Lubricator (CLLG-12-43). **CRC-198.** 7/16/43

Water Resistance of Lubricating Greases (CLLG-13-43). **CRC-199.** August, 1944

Dirt Count in Precision Instrument Greases (CLLG-14-43). **CRC-200.** 2/2/44

Fats and Fatty Acids for Lubricating Grease Manufacture (CLLG-15-43). **CRC-201.** 8/20/43

Determination of the Flow Characteristics of Lubricating Greases—the SOD Pressure — Viscosimeter (CLLG-20-43). **CRC-202.** Feb., 1946

Evaporation of Low Temperature Greases (CLLG-21-43). First Report, **CRC-203.** 8/1/44 Second Report, **CRC-204.** 5/1/45

Performance Characteristics of Wheel Bearing Lubricants (CLLG-25-43). **CRC-205.** 5/8/45

Final Report—Amphibian Wheel Bearing Grease (CLLG-37-44). **CRC-206.** 9/1/46

### HYDRAULIC FLUIDS

Memorandum on Density and Thermal Expansion (Cubical) of Hydraulic Fluids. **CRC-207.*** 9/3/42

Performance Requirements of Fluids for Hydraulic Jacks Used by Military Forces. **CRC-208.*** 7/2/43

Report of the Performance Group on the Substitution of Castor Oil in Shock Absorber and Brake Fluids. **CRC-209.*** 6/14/44

Report of the Properties Group on Recommended Requirements for Use in Revising U. S. Army Specification No. 2-111A. **CRC-210.*** 10/5/44

Recommendations to the Ordnance Department on the Inspection and Preservation of Test Parts from Stroking Tests (CRC L-14-944) on Hydraulic Brake Fluids submitted for Qualification Under U. S. Army Specification 2-111A. **CRC-211.*** Rev. 2/9/45

Recommended Requirements for Use in Revising U. S. Army Specification No. 2-112, Hydraulic Shock Absorber Fluids, Types I and II. **CRC-212.** 2/13/45

Joint Report of Coordinating Equipment Research Committee and CLR Hydraulic Fluids Groups concerning the Use of Additives in Shock Absorber Fluids. **CRC-213.*** 8/21/45

Recommended Requirements for Use in Revising U. S. Army Specification 2-112 Fluid, Shock Absorber, Type II, for the Purpose of Qualifying General Fluids. **CRC 214.*** 10/1/45

# CRC Issues Reports

NEW reports recently issued by the Coordinating Research Council follow.

The complete list of CRC Accumulated Wartime Technical Reports, 1942-1946, inclusive, appear on pp. 81 to 84 of the November, 1948, SAE Journal.

Those marked with an asterisk (*) are available in photostatic form only. Prices of these reports will be furnished upon request by the SAE Special Publications Department, 29 West 39 Street, New York 18, N. Y.

## FUELS

### AVIATION FUELS

**Detonation**

The Precision of Fuel Rating, 1942-1946 (Published in SAE Journal, June 1948). **CRC-215.** 6/24/47.

**Vapor Lock**

Aircraft Fuel Systems and Components

The Performance of Aircraft Fuel Pumps (V-4). **CRC-216.** 6/10/46.

The Performance of Aircraft Fuel Pumps (V-5, Supp. to V-4). **CRC-217.** 4/21/47.

**Volatility**

Analysis of Combined Full-Scale Volatility Data for the Period 1939-1947. **CRC-218.** 8/4/47.

### MOTOR FUELS

**Detonation**

Report of the CFR-MFD Road Test Reference Fuel Analysis Panel on the 1946 Road Test Program. **CRC-219.** 1/6/47.

**Gasoline Additives**

Report on Gasoline Gum Tolerance of Ordnance Materiel (Tests Conducted at Normoyle Field, San Antonio, Texas during the period October 15, 1944 to January 15, 1945), February 10, 1945, Revised. **CRC-220.** 6/19/45.

Report on Gasoline Gum Tolerance —Ordnance Stationary Engines (Tests Conducted at Ethyl Corporation, San Bernardino, California during the period August 9, 1945 to September 8, 1945), September 14, 1945, Revised, June 3, 1946. **CRC-221.** 2/6/47.

Report on Gasoline Gum Tolerance of Ordnance Materiel (Tests Conducted at Camp Bullis, San Antonio, Texas, during the periods October 15, 1944 to January 15, 1945 and April 16, 1945 to June 1, 1945), July 14, 1945, Revised, November 15, 1945. **CRC-222.** 6/3/46.

Report of Investigations—National Motor Gasoline Survey, Winter 1946-1947, August 1947.

**Survey***

Report of Investigations—National Motor Gasoline Survey, Summer 1947, January 1948.

Winter and Summer National Gasoline Survey Reports on the properties of motor fuel sold through service stations in the United States have been issued regularly since 1935, except for the Winter 1941-1942 and the 1942 Summer Survey. These reports, compiled from data supplied by members of the Coordinating Fuel and Equipment Research Committee, have been issued by the Bureau of Mines. Since the conduct of the surveys and the preparation of the reports has passed the formative stage, and no longer constitute a research undertaking, continuation of the cooperative arrangement with the Bureau of Mines for the conduct of these semi-annual motor gasoline surveys has been transferred to the American Petroleum Institute, effective with the Winter 1947-1948 Survey.

**Volatility**

Report on CFR-MFD Vapor Lock Road Tests (Conducted at Indio, California, August 26, 1946 to September 14, 1946). **CRC-223.** 1/10/47.

### DIESEL FUELS

Report of the Performance Characteristics Group, CFR Diesel Fuels Division. **CRC-224.** 5/22/47.

## LUBRICANTS

### GREASES

Storage Stability of Greases (CRC Project No. CLLG-19-43). **CRC-225.** 8/18/47.

* Copies of all the Survey reports are available through the U. S. Bureau of Mines.

# Operating Economies

Cont. from P. 60

when additional lubricating oil was permitted to reach the cylinder walls. This reduced wear rate considerably, although the rate at 104 F was still about four times as great as at 176 F. This may explain why wear rates of large engines—with independent, measured lubrication to cylinder walls—are not too bad, even when operating at relatively low temperatures.

But it's obvious that they should do better at higher temperatures and also use less lube oil.

It is also important to keep cooling water free from air and other gases to reduce scale and corrosion. Easiest way to do this is to maintain cooling fluid temperature at the boiling point, as in "vapor phase" cooling. This method permits evaporative cooling of any size or type of engine.

It reduces attendance costs, maintenance items—such as filter packs and lubricating oil—as well as repair parts and labor for overhauls. Where raw make-up water of suitable quality is available, "vapor phase" cooling reduces initial cost for equipment by eliminating all heat exchanger surface and fans. (Paper "Marine and Industrial Type Diesel Engines Operation

One of the strongest selling statements that can be made regarding any engine-powered equipment is this:

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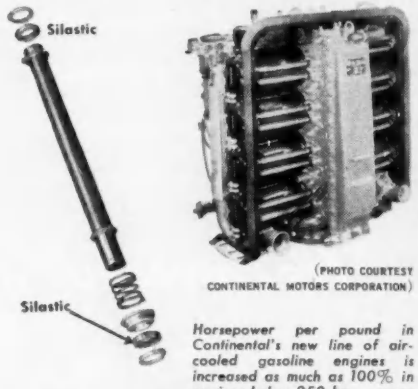
Silicone News

DC SILICONES

## More Power Per Pound†

Call it plain laziness or call it "divine discontent", some potent force has driven us to seek more concentrated motive power ever since man started to move on wheels. But each increase in horsepower per pound has increased operating temperatures and created a need for more heat resistant materials. Dow Corning Silicones help to supply that need in such major developments as the new air-cooled gasoline engine by Continental Motors Corporation of Detroit.




(PHOTO COURTESY CONTINENTAL MOTORS CORPORATION)

*Horsepower per pound in Continental's new line of air-cooled gasoline engines is increased as much as 100% in engines below 250 hp . . . more than 300% (down from 2400 to 777 lbs.) in the horizontally opposed 8 cylinder 250 hp engine shown above. In this type of engine, Silastic* gaskets are essential parts of the standard push-rod and tube assembly.*

Among the many problems solved by Continental engineers in designing this compact power plant, was the leakage of oil around the push-rod tube assembly. Hot oil and operating temperatures up to 500° F. severely limited the life of conventional gasketing materials. Continental engineers, however, knew about Silastic, the rubber-like Silicone by Dow Corning, and they asked for samples and technical assistance.

Silastic solved this problem because it is more heat-stable and more resistant to hot oils and to permanent deformation at temperatures above 200° F. than any other resilient material. Use of engines in sub-zero weather is not restricted by these gaskets of Silastic 161 because they are serviceable from —90° to 500° F. For more information about Silastic, ask for data sheet No. F-5D.

†See Silicone News, Dec. 1947, for story on 50% reduction in size and weight of electric motors made possible by Dow Corning Silicone Insulation.

*TRADE MARK REGISTERED U. S. PAT. OFF.

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Dow Corning
FIRST IN SILICONES


and Maintenance," was presented at SAE National West Coast Meeting, San Francisco, Aug. 19, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

## Section News

Cont. from P. 80

drivers of midget racing cars at a dinner at the Airport Inn in Troy, then journeyed out to the Empire Raceways in Menands, N. Y. to learn more about the sport.

Highlights of the evening were a tour through the pits at the track and interviews with owners and drivers. Members had a chance to examine the Ford 60 and the Offenhauser engines, the two engines most common at the track that evening.

Harvey Tattersall, Jr., handicapper of the American Racing Drivers Club, and Carl Ruopp, of Empire Raceways, answered technical and general questions about midget racing.

Preceding the main event of 25 laps entered by 14 cars, were three qualifying heats, two semifinals, and a consolation race.

## Law Describes Idlewild at Met Section Meeting

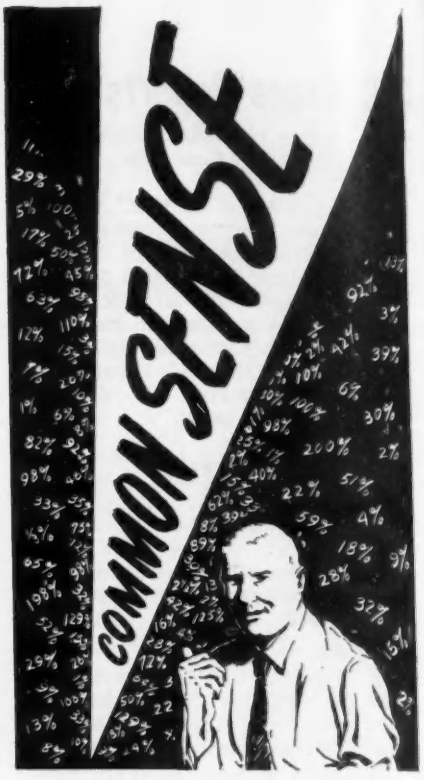
—A. B. SAXMAN, Field Editor

METROPOLITAN Section, Sept. 16—The New York International Airport is about five times as large as La Guardia Airport, will handle some 1,000 flights a day, and can be used in practically zero-zero weather, New Yorkers learned from Hervey F. Law, General Superintendent of Airports for the Port of New York Authority.

The entire field measures 7 x 5 miles, an area equal to the area from the Battery to 42nd Street in Manhattan. To complete the field, some 63,000,000 cu yd of fill are being added. About 10,000,000 cu yd of earth are being moved in leveling operations. At present, over 95% of the work has been completed. Water supply and drainage required 40 miles of pipe in diameters from 8 to 72 in.

Runways are 200 ft wide with 100-ft asphalt shoulders on both sides. Concrete surface is 12 in deep. Three runways are now in use, one 6,000 ft, another 8,000 ft, and a third 8,200 ft long.

All modern means of field and runway orientation have been used, in-


COMMON SENSE in the shop would seem to call for careful cutting fluid application, because oil that improves one operation may not be right for something different. *There just isn't any "one shot" cutting fluid that can do a large percentage of all jobs!* Consider all the variables—the wide variety of speeds, feeds, materials, tolerance and finish requirements encountered in machining operations in one shop. Those are the considerations that make it economical in the long run to be sure the cutting fluid you use is scientifically correct. "On-the-job" tests help you determine what cutting oil qualities are needed, and may even result in a decrease in the number of oils now used. It is plain common sense to call in cutting oil experts . . . people with a sound background of practical experience who can be relied upon to recommend the right cutting fluid for the job.

—Chip

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cluding GCA, ILS, and high-intensity vertical lights at the ends of runways.

Land erosion adjacent to runways and in open portions of the field has been controlled by beach grass plantings. Each stalk acts as snow fence to keep sand in place and prevent it from causing a surface haze or damage to aircraft.

Latest and largest types of fire-fighting equipment have been installed at the field. Two fire-fighting trucks are equipped with carbon dioxide, water-mist, and foam spray equipment.

When fire trucks have to leave runways and traverse sand, they roll on special sand-type tires. A truck that will carry a 42,000 lb load across the sand is being developed.

## Geschelin Discusses New Passenger Cars

—R. V. LARSON, Field Editor

CENTRAL ILLINOIS Section, Sept. 27—Joseph Geschelin outlined to members what they can expect in their new cars—when they get them.

Demand for wide seats, the Detroit editor of Chilton Co. said, has necessitated shifting the engine to the extreme front so that seats can occupy the middle of the chassis. This weight distribution has increased the brake loading on the front wheels.

Also, the new super balloon tires on small wheels limit the brake drum diameter, adding to the braking problem. Geschelin hinted that if these trends continue, the solution may be to put the engine in the rear.

Controlled-frequency engine mountings have practically eliminated engine "feel" through the accelerator pedal, he said.

Transmissions are definitely headed toward the torque converter, Geschelin believes. Overdrives he finds are becoming more and more popular.

He expects no major changes in suspension systems. Torsion-bar and rubber suspensions are being developed, but are not likely to be in production soon. Nonsymmetrical semi-elliptical rear springs are being tried to reduce pitching on quick stops, he continued.

The steel shortage—and not engineering economy—has brought on the use of aluminum, and he added, new torque converters have aluminum castings made by a new plaster mold method and feature smooth and accurate contours.

First question Geschelin was asked was, "When can one get a new car?" The answer was not optimistic; Geschelin estimated that the automotive industry is about 26 months behind on present orders.

## Cornell Seeks to Save Lives in Airplane Crashes

—BENJAMIN FUENTE, Field Editor

BUFFALO Section, Sept. 29, 1948—Airplanes will crash, and Cornell University is seeking the secrets of designing airplanes that can crash without killing their occupants, Edward Dye, manager of the Development Division of Cornell's Aeronautical Laboratory, told this Section.

The Cornell research team is made up of members of the faculty, the Cornell Medical Center, and the Aeronautical Laboratory, Dye explained.

A large percentage of fatalities in aircraft crashes is due to head injuries, the group found from statistics, so they are determining how to protect the head. Since heads resemble eggs in structure—and even at 80¢ a doz,

eggs are cheaper—eggs have been substituted for heads in experiments.

Dye reported that eggs have been subjected to 100 g without cracking and that eggs have survived impacts far more severe than crash impacts. Impact safety has been accomplished by strapping the egg to the carrier, surrounding the egg with a material that absorbs energy without releasing it again in spring fashion, and by allowing the egg to move forward with definite deceleration.

Dye emphasized that these principles can be incorporated in airplane design. Meantime, passengers can protect themselves in crashes by leaning their heads against the backs of seats directly in front of them, thus minimizing relative motion between the head and object that will stop it.

Making the public safety conscious helps the aircraft designer, Dye explained. When the public is made more safety conscious, designers can incorporate all safety features now known without fear of negative reaction from the traveling public.

Dye supplemented his talk with a film "To Design for Living" showing some of the tests performed in the search for the crash-safe airplane.

## Cotton Forms Base of Plastics for Seals

—A. D. TRAGER, Field Editor

ST. LOUIS Section, Sept. 21—Cotton forms the base of two plastics described by E. A. Russell, Chief Engineer of Spaulding Fibre Company, Inc.

One of his company's products is a vulcanized fibre made by gelatinizing a cotton-base paper sheet in a zinc chloride bath, then leaching the sheet stock in water, drying, and calendering. The other material, a laminated thermosetting plastic, is made by bonding together several plies of fabric- or paper-base stock impregnated with cotton, glass, synthetic, or asbestos fibres, Russell explained.

Water-pump washers produced from these plastics serve also as thrust bearings. Gears, made of the laminated plastic serve in speedometers, oil pumps, and windshield washers. Almost all makes of distributors use the laminated plastic for breaker-point rubbing blocks. Plastic washers are replacing the more expensive bronze bushings for differential side gears in one type of rear axle. Radiator filler caps also use the laminated plastic, which swells slightly on contact with water, thereby forming a more effective seal.

Chairman Adolph Jeude presented a scroll to 1947-1948 Chairman Robert Slattery in recognition of his work and introduced the Governing Board.

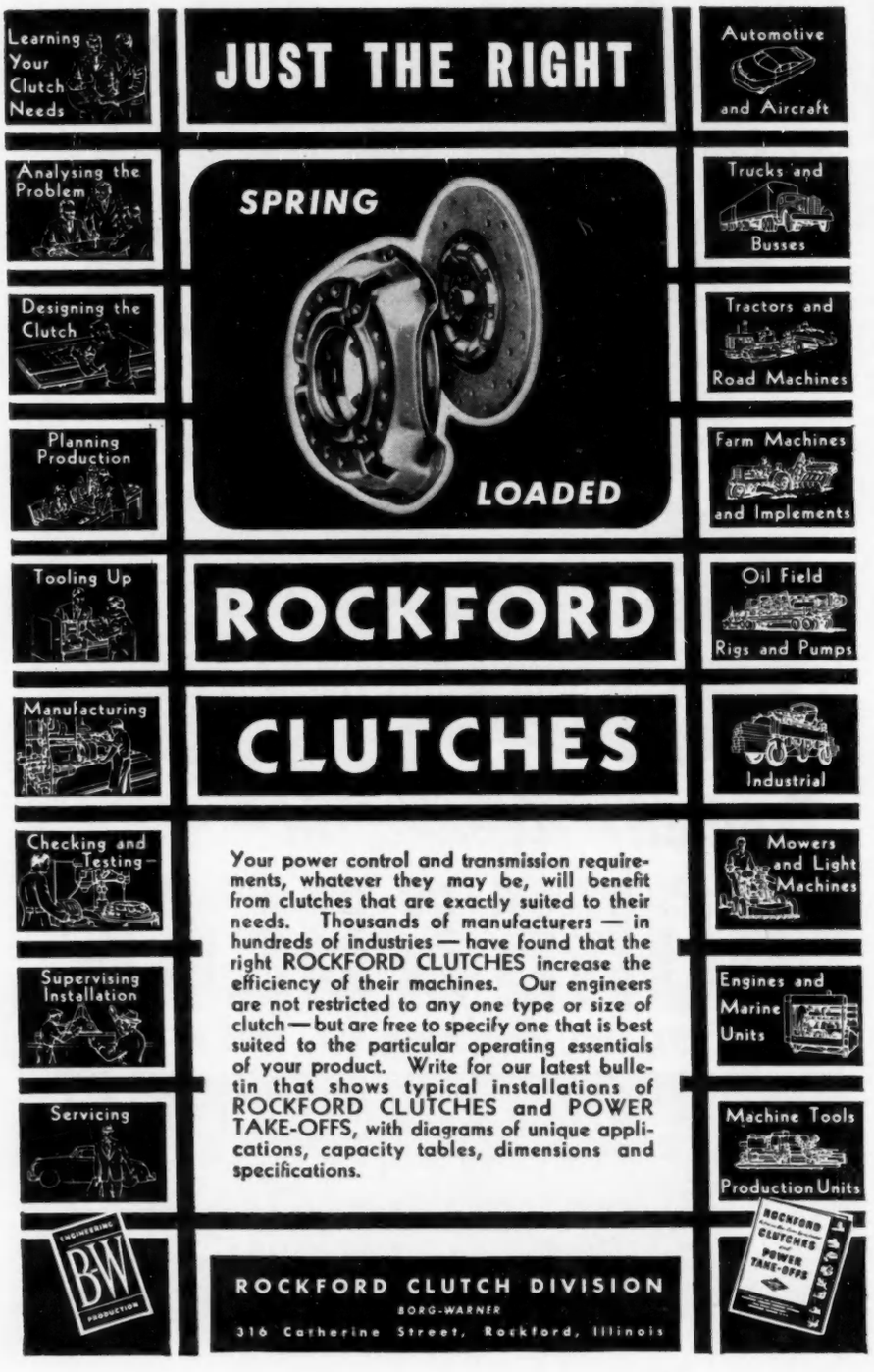
## More Cars Will Adapt Frameless Construction

—H. W. EPLER, Field Editor

WILLIAMSPORT Group, Sept. 13—Radical changes in styling and construction that now characterize several makes of cars will appear in 1949 models of others, Joseph Geschelin, Detroit Editor of "Automotive Industries" and SAE Vice-President, told 80 people at the opening of the Group's fourth season.

The new styling is made possible by a new concept in chassis design—the frameless construction which combines chassis and body into one unit. Geschelin said, adding that frameless construction requires an entirely different manufacturing plant layout. Small-scale plastic models of the Hudson car illustrated step-by-step processes in assembly.

Geschelin pointed out that the cur-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rent trend toward moving seats and engine forward has resulted in excessive brake loads on the front-wheel brakes and that designers have now reached the limiting brake load. Any further style changes advancing the center of gravity will make it necessary to move the engine to the rear of the car.

With regard to powerplants, Geschelin mentioned that several manufacturers have redesigned their engines to take care of foreseeable high compression ratios without major alteration and will start next year with 8:1 for use with present premium fuels.

Use of light alloys in cars at the present time, said Geschelin, is primarily to save steel and not a matter of engineering economy.

Prior to the introduction of the speaker, Walter Jamouneau, retiring chairman, was presented with a certificate from the Council of the Society in recognition of his untiring efforts and leadership during the past year.

## Diesels Here to Stay Despite Gas Turbines

—H. W. EPLER, Field Editor

WILLIAMSPORT Group, Oct. 4—Even with the competition of the gas turbine, diesel development continues and the day of the diesel is not drawing to a close, said Prof. E. B. Watson, Associate Professor of Mechanical Engineering at Cornell University.

Major problems today in diesel engine design, according to Watson, concern the fuel-injection pump and fuel-air mixing for high thermal efficiency. He emphasized the high-precision machining required in the manufacture of fuel-injection pumps, its reflection in their cost, and the constant effort to simplify and improve their design.

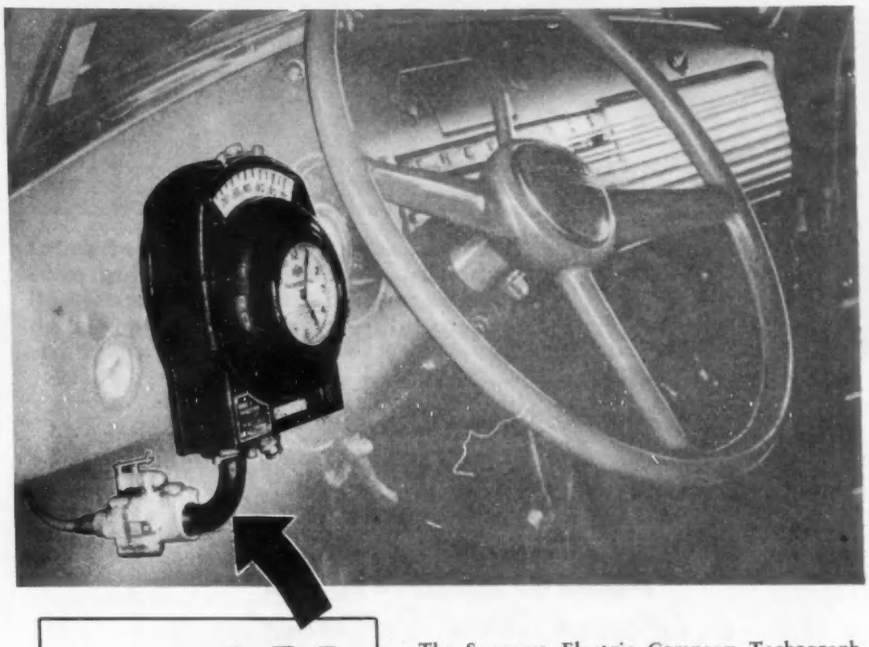
The high cost of the fuel-injector pump, which is 10 to 15% of the cost of the engine, limits the use of diesel engines in the automotive field.

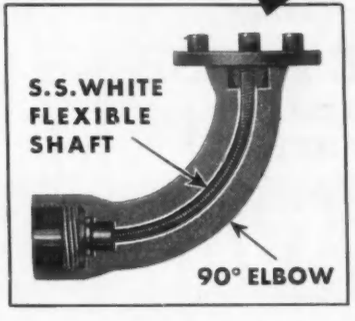
He mentioned that at the present time fuel-injection pumps are tailor-made by the pump manufacturer to meet the individual engine manufacturer's requirements, thereby relieving him of the responsibility for design of this complicated mechanism and making it possible for owners to convert easily to diesel power.

Engine manufacturers, said Watson, are using welded steel frames to reduce weight on large diesels, a practice of General Motors in their locomotive engines.

Supercharging, according to Watson, is becoming increasingly important. It was found, for example, that an exhaust-turbine supercharger increased power output 50% on one engine. The


# A *little* 3½" FLEXIBLE SHAFT LICKED THIS ANGLE DRIVE PROBLEM






(Above) Cutaway view showing S. S. White flexible shaft in operating position. Note the shaft's integral square swaged end which engages a square hole in the drive tip of the Tachograph rotor shaft.

*Photos courtesy of*
*Sangamo Electric Company*
*Springfield, Illinois*

**The Sangamo Electric Company Tachograph, above, is used on trucks and other commercial vehicles to make graphic records of vehicle speeds, miles traveled, stops and engine running time. It is driven by the speedometer drive shaft through an adapter and includes a clock, a speedometer and an odometer.**

Originally the 90° turn from the adapter to the Tachograph was made through gears. But, the friction load imposed by the gear box and the Tachograph in cold weather caused a number of speedometer shaft failures.

**This was remedied by replacing the gears with a 3½" S. S. White flexible shaft running in a 90° steel elbow, as shown above. The manufacturer says, "Complaints of broken speedometer shafts have been negligible since adopting the flexible shaft, which has been used on many thousand Tachograph installations."**

Think of S. S. White flexible shafts next time you are faced with an angle drive problem.

## WRITE FOR FLEXIBLE SHAFT HANDBOOK

**260 pages of facts and technical data to help you select and apply flexible shafts. Copy sent free, if you ask for it on your business letterhead and mention your position.**

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direct-driven positive-displacement supercharger is more economical for small engines.

Nordberg dual-fuel engines, which permit choice of either gas or diesel fuel or varying proportions of either fuel, are very successful in the Southwest where gas is cheap, Watson reported.

## Pigott, Warner Visit Colorado

—D. H. LAMB, Field Editor

COLORADO Group, Sept. 29—SAE President Pigott and General Manager John A. C. Warner were guests at a meeting held in the Research Laboratories of the Motoroyal Oil Company.

Highlights in Pigott's talk on "Developments in Fuels, Lubricants, and Lubrication" were . . .

"Many have thought we should be using 100-octane gasoline in passenger cars shortly. This foolish idea needs debunking."

"Until the injector system is about as cheap as a carburetor system, it will not see much application to gasoline engines."

"Design of a bearing has much more controlling influence on successful operation than any oil that may be used in it. When babbitt was the major bearing material, we never heard of bearing corrosion, but since loads have increased in many designs beyond the fatigue resistance of babbitt, the newer materials have brought the corrosion problem. Since corrosion is largely caused by organic acids developed in the oil by oxidation, the cure is anti-oxidation additives."

Later, the Motoroyal Oil Company was host at a smorgasbord lunch.

## Current Body Contours Only Part of Style Cycle

—R. E. JOHANNSON, Ass't Field Editor

SOUTHERN NEW ENGLAND Section, Oct. 7—Austin M. Wolf separated the wheat from the chaff of recent automotive developments for 120 members and guests—including one who had come from Kalamazoo to hear Wolf—at the Section's opening meeting, held at Trinity College.

Car styling runs in cycles, Wolf said, and when the extreme in present "blubber" styling is reached, there may well be a return to more severe lines. The bulges are intended to suggest luxury and spaciousness, but are not functional. They increase repair work charges, a fact recognized by insurance companies in setting higher premium rates on late-model cars. They also require more expensive dies and more

labor expense, which raise the price to the customer, he added.

Higher compression ratios are increasing economy. The 1949 Oldsmobile and Cadillac cars will have reinforced blocks and compression ratios of 8:1. As gasolines advance, the same block will be fitted with other heads, ultimately bringing compression ratios up to 12:1, Wolf reported.

There are no fully automatic transmissions which are truly efficient, Wolf stated. Although the torque converter is smooth, it is efficient only through a small range of speeds, he said.

Most designs now incorporate a natural oscillation period of 60-90 cpm, corresponding to natural walking frequencies. Other factors Wolf credited as contributing to the remarkable comfort of today's automobiles are developments in front-wheel suspensions, engine mountings, and fluid-drive mechanisms.

## N. E. Prepares for Cold Weather

—A. R. OKURO, Field Editor

NEW ENGLAND Section, Oct. 5—Crankcase insulation, top oilers, and variable-pitch fans possess merit for certain types of operation, but general use is not warranted because of increased cost and possible complication of service procedure, Ralph H. Kress said in answer to questions on "Winter Operating Problems," at the Section's first meeting of the 1948-1949 season.

Kress stressed the importance of operating cooling systems at temperatures between 160 and 180 F, careful selection of lubricants to suit the vehicle and type of operation, and adequate crankcase ventilation.

Guests at the meeting were Carl A. Swanson and Robert M. Wallace of the faculty of Wentworth Institute and 14 of their students.

## Applications Received

The applications for membership received between Sept. 10, 1948, and Oct. 10, 1948 are listed below.

**Baltimore Section**

Allen G. Barclay.

**Buffalo Section**

Peter C. Bila.

**Canadian Section**

Earl Aikin, Stanley Charles Malcom Ambler, James Campbell Brownlee, George R. Jackson, James G. Rae, William Rowe.

**Central Illinois Section**

David Blattner, Dale S. Gronsdahl, Charles S. Morris.

**Chicago Section**

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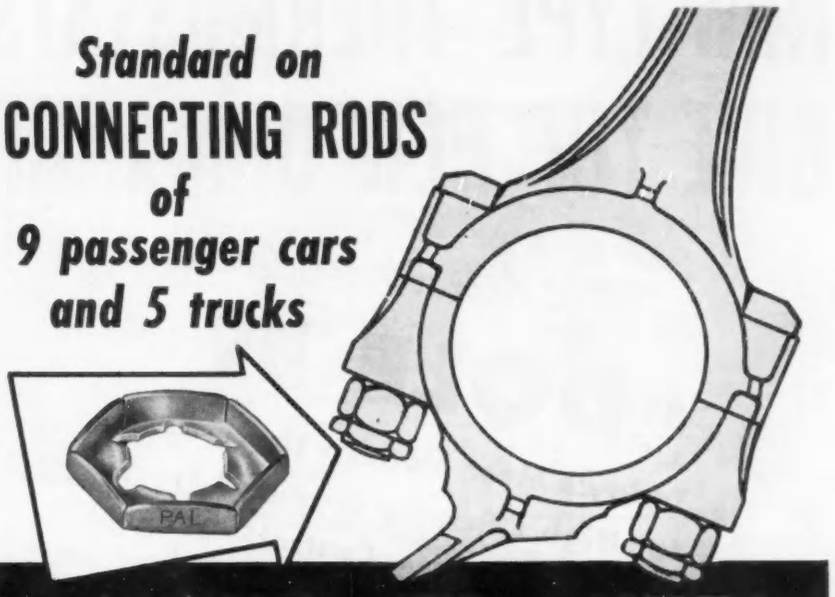


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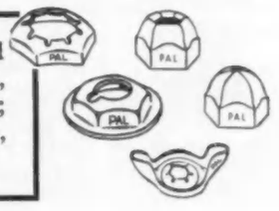

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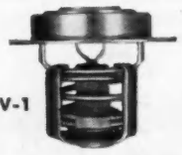

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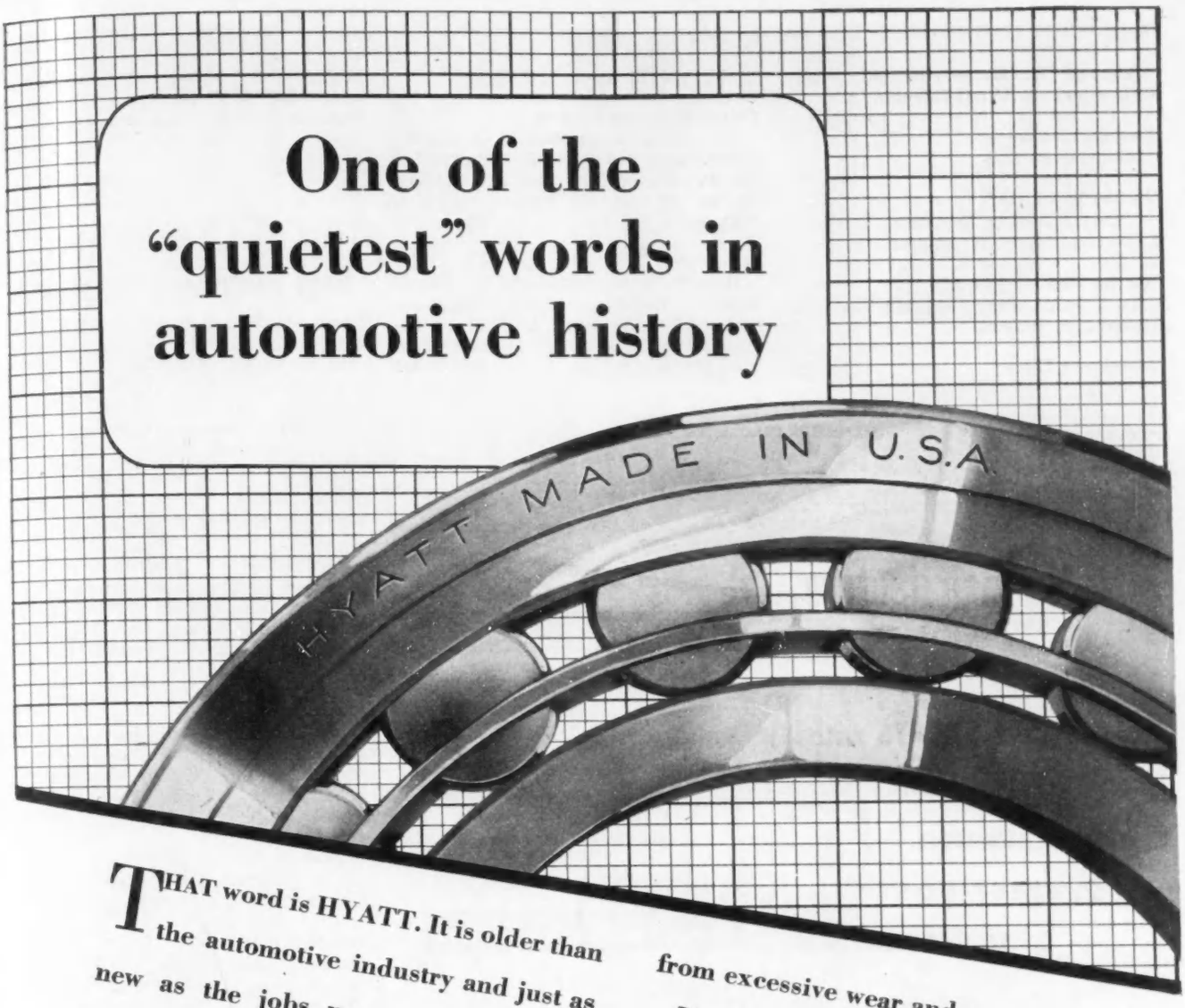


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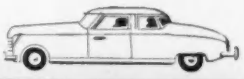

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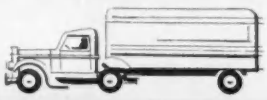

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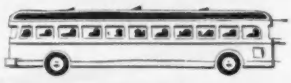

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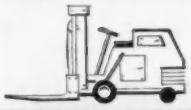

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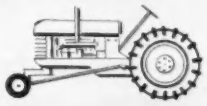

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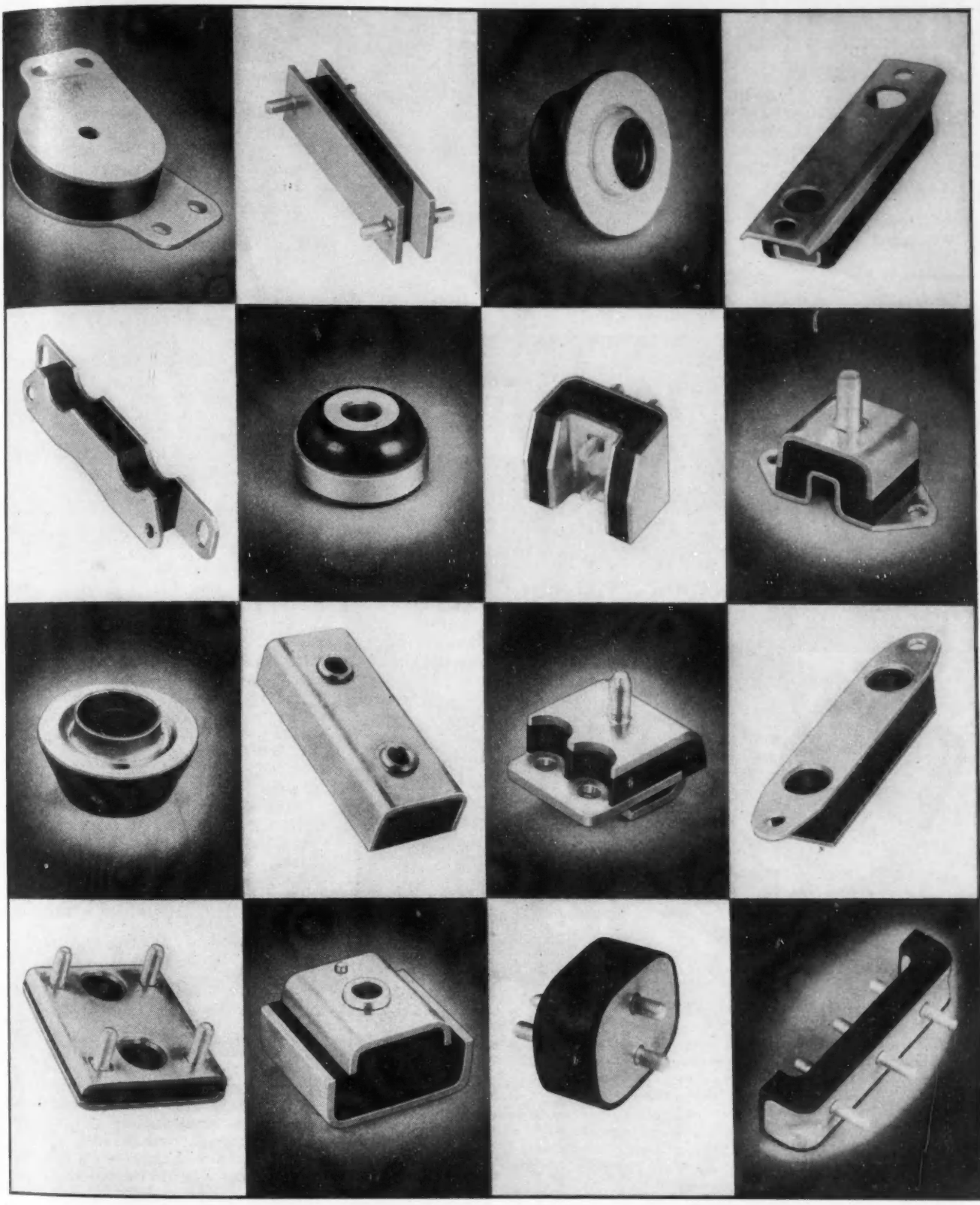

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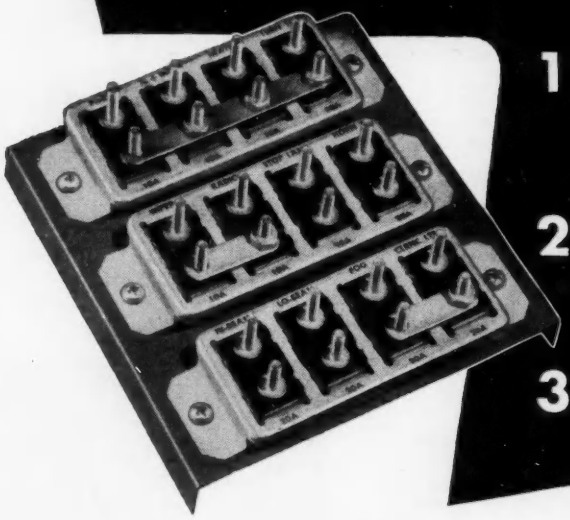

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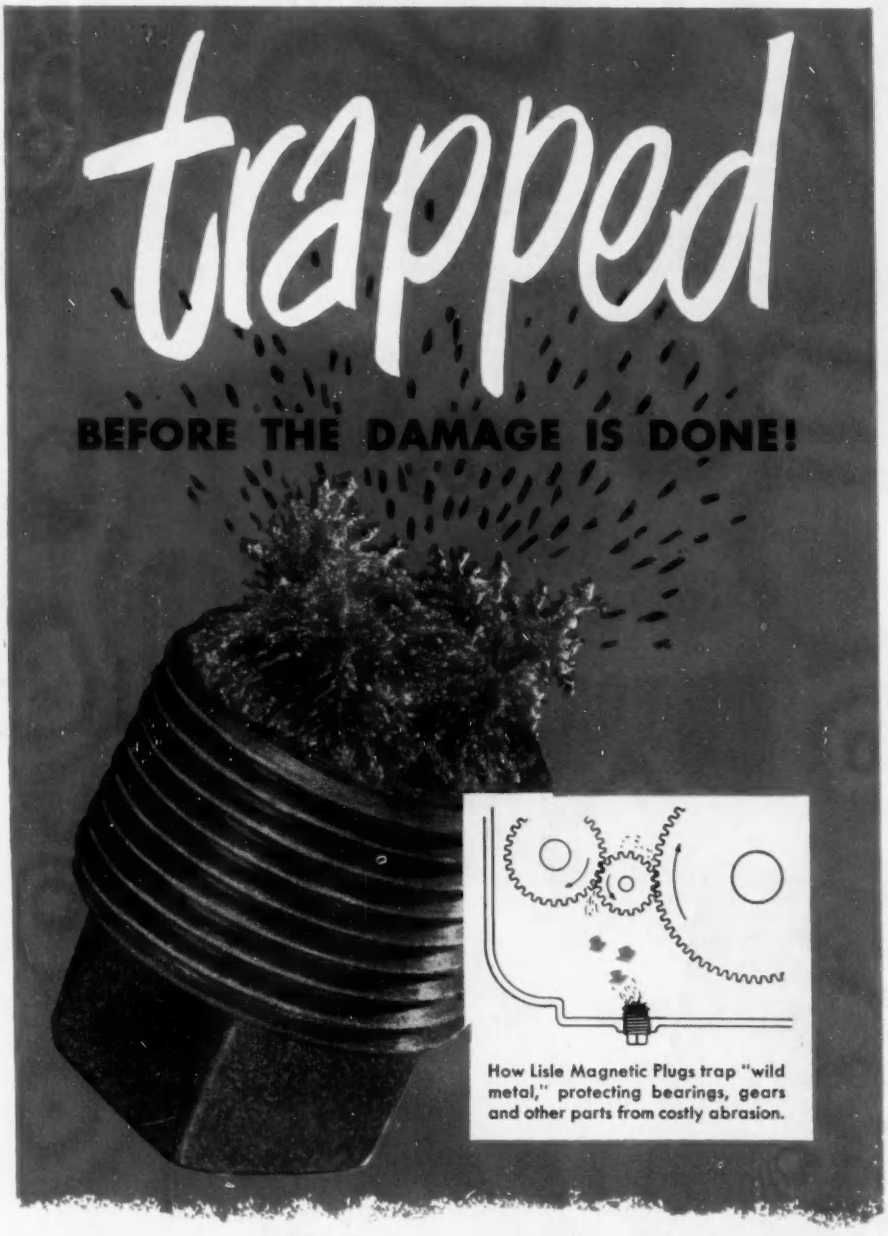
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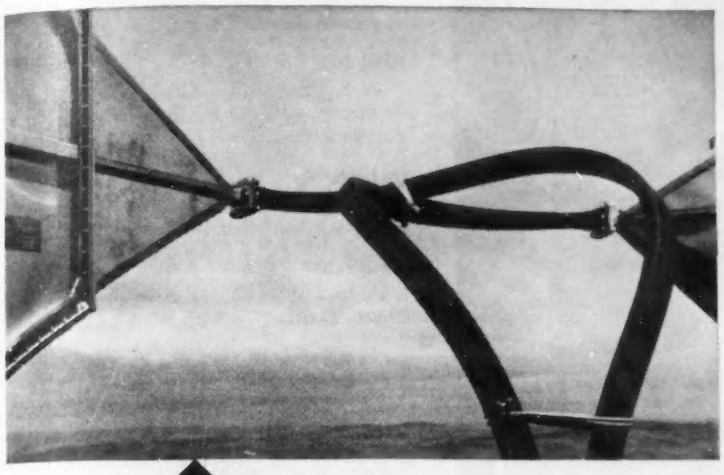
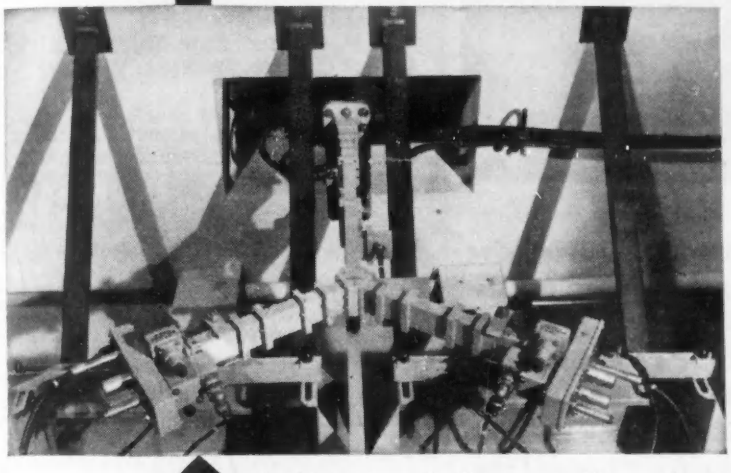
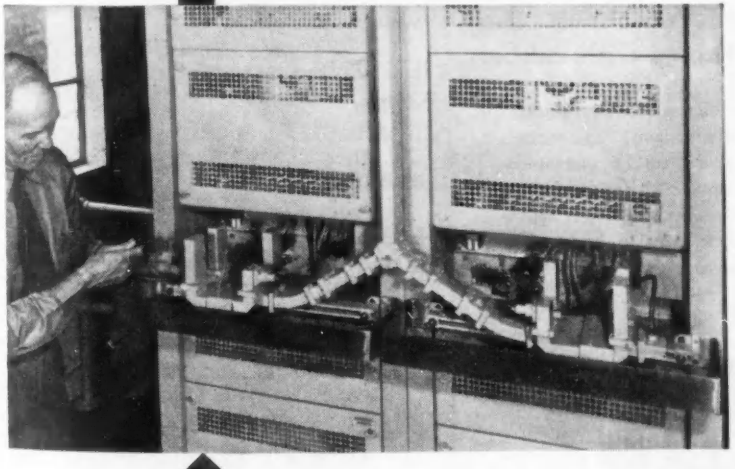


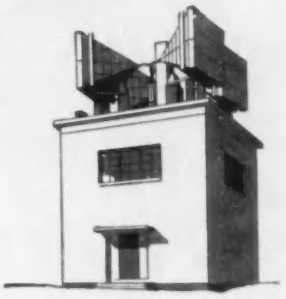
3 The waveguide connects with horn antennas which are pointed toward similar antennas at the next stations miles away.



2 Looking upward, the waveguide continues through the roof of the station toward the antennas.



1 Base of a waveguide circuit in a repeater station of the New York-Boston radio relay system.



# Pipe Circuits

UNLIKE radio broadcast waves, microwaves are too short to be handled effectively in wire circuits. So, for carrying microwaves to and from antennas, Bell Laboratories scientists have developed circuits in "pipes," or waveguides.

Although the waves travel in the space within the waveguide, still they are influenced by characteristics found also in wire circuits, such as capacitance and inductance. The screw or stud projecting inside the guide wall acts like a capacitor; a rod across the inside, like an inductance coil. Thus transformers, wave filters, resonant circuits – all have their counterpart in waveguide fittings. Such fittings, together with the connection sections of waveguide, constitute a waveguide circuit.

From Bell Laboratories research came the waveguide circuits which carry radio waves between apparatus and antennas of the New York-Boston radio relay system. The aim is to transmit wide frequency bands with high efficiency – band widths which some day can be expanded to carry thousands of telephone conversations and many television pictures.

Practical aspects of waveguides were demonstrated by Bell Telephone Laboratories back in 1932. Steady exploration in new fields, years ahead of commercial use, continues to keep your telephone system the most advanced in the world.

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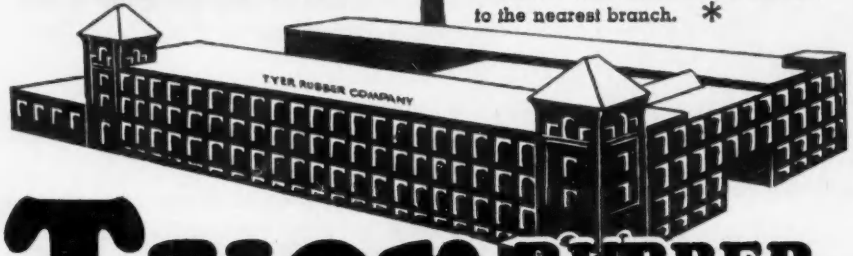


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